Exhibit O

Exhibit 1

Expert report of Stephen McKeon, Ph.D.

December 27, 2019

Securities and Exchange Commission v. Telegram Group Inc. and TON Issuer Inc

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I. ASSIGNMENT

1. I have been retained by the law firm, SKADDEN, ARPS, SLATE, MEAGHER & FLOM LLP ("Counsel"), counsel for Telegram Group Inc. and TON Issuer Inc (the "Defendants") in the matter of *Securities and Exchange Commission v. Telegram Group Inc. and TON Issuer Inc.* Counsel has asked me to review documents related to this case and to opine on the economic features and objectives of the Telegram Open Network ("TON") blockchain and its native cryptoasset, Grams. My opinions are stated below.

2. FTI Consulting ("FTI") staff working under my supervision and I have reviewed certain documents and publicly available information as described in Appendix A. All opinions are my own.

3. I am being compensated at $850 per hour in this matter. My compensation is not dependent on reaching certain opinions or the outcome of this litigation.

4. A list of documents relied upon in forming my opinions is provided in Appendix A. I respectfully reserve the right to supplement, change, or modify my conclusions and summary of opinions, if additional information becomes available.

II. QUALIFICATIONS

5. I am an Associate Professor of Finance at University of Oregon, a Visiting Associate at the Cambridge Centre for Alternative Finance, and a Partner at Collaborative Fund, a venture capital firm that invests in early stage technology and consumer goods companies. In all three roles, my primary focuses are blockchains and cryptoassets.

6. I earned a Ph.D. in Management with a Finance focus, and a Masters in Economics, from Purdue University. Since the beginning of my academic career, I have been studying financial

securities. I have published several articles in top finance journals on securities and legal topics, such as debt financing, corporate risk-taking, state anti-takeover laws, and private equity.

7. Beginning in 2016, I have been actively teaching and researching blockchains and cryptoassets. I have taught these subjects at University of Oregon, University of Cambridge, and University of California, Berkeley, often with a focus on the regulatory environment around cryptoassets.

8. Most recently, in 2019, I conducted research on blockchains at the Cambridge Centre for Alternative Finance, one of the leading research groups in the world within academia on the topic of blockchains, with a focus on publications targeted towards practitioners. As the result of this research, I co-authored a publication titled "2nd Global Enterprise Blockchain Benchmarking Study", which analyzed data on 67 live blockchain networks and reported findings on user motivations, use cases, rates of adoption, and technical features such as consensus algorithms.

9. I have also authored an article on ancient antecedents to Bitcoin, published in *Economic Anthropology*, as well as two chapters, titled "Law and Blockchains," and "Blockchain Trading and Exchange," which are forthcoming in the *Handbook of Technological Finance*.

10. I have written about the intersection of blockchains and financial securities in a series of articles published on the Medium website, and they have been viewed over 100,000 times as of this writing, ranking them among the most widely read articles on this topic. Additionally, I have ongoing work-in-progress researching cryptoasset ratings and their impact on returns.

11. I frequently participate in public speaking at major conferences on the topic of cryptoassets, often on the topic of financial securities on blockchains (i.e. security tokens). I have spoken at Consensus Invest, Fluidity Summit, Digital Asset Summit, Security Token Summit,

Wall Street Blockchain Alliance, and the annual meeting of the Financial Management Association.

12. At Collaborative Fund I focus on a portfolio of investments around blockchain technology. My hands-on experience in evaluating blockchain projects, technologies and related cryptoassets, similar to the anticipated design of TON and Grams, provides valuable insights into, and understanding of, how purchasers view these digital assets and the potential sources of their value accrual. I have personally observed and participated in governance processes at comparable projects during and subsequent to mainnet launch, which is the moment when a cryptoasset is generated and distributed for the first time. My work at Collaborative Fund has also informed my understanding of the various participants in a blockchain ecosystem such as exchanges and staking service providers, as I interact with these parties on a regular basis. Collaborative Fund never purchased and presently does not own any Gram tokens in its portfolio.

13. My Curriculum Vitae is attached as Exhibit 1 to this report.

III. SUMMARY OF ASSUMPTIONS

14. The conclusions of my report are based on several assumptions. First, I assume that at the time of the contemplated public distribution of Grams, TON will be fully operational and have governance structure, consensus protocol, block validation mechanism, decentralized services and other features as described in the materials I reviewed and relied upon listed in Appendix A, subject to the additional assumptions below. I have not reviewed the TON source code, nor do I claim to have expertise as a software engineer or blockchain code developer, which would be required to conduct such a review.

15. Second, I assume that the market stabilization feature, in which Grams would be repurchased if the price falls below a pre-specified value based on the pricing formula in the TON White Paper,[1] will not be implemented.

16. Finally, I assume the TON Foundation will not participate in staking and validation. I am cognizant that the TON Foundation has not been formed as of the date of this report, and in fact may never be formed.

IV. SUMMARY OF OPINIONS

17. All of my opinions stated below represent my assessments of the characteristics and features of the TON blockchain and Gram cryptoasset as of the future date of the TON mainnet launch and contemplated distribution of Grams, conditional on the assumptions stated in Section III of this report. As of the present moment, such future date is uncertain due to the pending litigation.

18. It is my opinion that Grams are designed to be most consistent with the cryptocurrency and utility tokens categories within the taxonomy of cryptoassets, upon the launch of a fully functional TON mainnet. Grams will be a cryptocurrency to the extent they are intended to be used for external payments and as a store of value. Grams will also be utility tokens to the extent that they are an integral part of the TON's governance mechanism, Proof of Stake ("PoS"), and will be a medium of exchange for a variety of consumptive services within the TON ecosystem. Grams are designed to be fundamentally different from tokens that represent ownership claims on financial securities (i.e. security tokens). My opinion on the taxonomy classification of Grams is based on my experience and research and is described in more detail in Section VI.

[1] Unless otherwise noted, all references to the "TON White Paper" refer to the March 2, 2019 version.

19. It is my opinion the TON blockchain architecture is designed such that it will not require essential management expertise from Telegram, the TON Foundation (if it is ever established), or any other single actor to function. Upon the launch of the mainnet, TON blockchain is designed to be a trustless decentralized blockchain that has no central authority, and to be executed and managed by a decentralized set of validating nodes. Moreover, the TON blockchain architecture allows for broad participation of the user community in the process of validating transactions. Neither Telegram, its employees, nor the TON Foundation are anticipated to participate in validating transaction blocks—the most essential operation of any distributed ledger. This opinion is based on my analysis of the information contained in the TON White Paper as well as my experience analyzing other PoS blockchain networks. The evidence and analysis supporting this opinion is found in Section VII.

20. It is my opinion that Telegram has positioned itself to be a participant in the network as opposed to an essential manager. This opinion is based on the fact that TON is open source software that can be freely replicated by any party, and that neither Telegram nor the TON Foundation (if it is established) retain any proprietary intellectual property rights to the source code. Use of the transaction processing capabilities of the network, as well as development of applications on top of the platform, will be largely non-excludable, meaning that neither Telegram, nor any other participant, will be able to restrict a user from these activities after mainnet launch. There is already substantial evidence of development activity around applications and services by third-party contributors. Evidence and analysis of the features of open source software development are found in Section VIII.

21. Based on my review of case documents and the assumptions stated above, I conclude that a wide variety of consumptive uses for Grams will exist and be available to Gram

holders upon mainnet launch and that the marketing of Grams is focused on consumptive uses. Some of the consumptive uses will be native to the TON blockchain (e.g., TON Storage) while some will be expanded through participation by third-party applications developers, particularly third-party wallets. The evidence on consumptive use cases for Grams and external development activities is presented in Section IX.

22. It is my opinion that the essential service of TON, transaction validation, is designed to be more decentralized than blockchain protocols such as Bitcoin and Ethereum. This opinion is based on empirical analysis of block production within Bitcoin and Ethereum, as reported by several academic articles, as well as my review of data from block explorers in December 2019. The majority of block production is dominated by four mining pools in Bitcoin and three mining pools in Ethereum. In contrast, TON is designed to have at least 100 validators, over 2/3 of which are required to sign valid blocks. Furthermore, TON is designed to be more decentralized than EOS, a delegated PoS blockchain that suffers from voting cartels due its use of delegated voting. The evidence underpinning this opinion is reported in Section X.

23. It is my opinion that the value of cryptocurrencies and utility tokens, such as Grams, are generally determined by (i) network effects (i.e. number of users), (ii) token functionality (i.e. consumptive uses cases), and (iii) systematic returns to the cryptocurrency market. With respect to Grams, Telegram's user base for its Messenger application, which is pre-existing at the time of anticipated mainnet launch and, while independent of the TON blockchain, is expected to contribute to the initial user base for Grams, is relevant for determinant (i). The Proof-of-Stake consensus protocol and multichain design of the TON blockchain, and well as the open source nature of application development—all intended to facilitate scalability and enable a broad spectrum of decentralized economic uses of Grams—are relevant for determinants (i) and (ii).

Systematic returns (determinant iii) are those factors that influence market-wide prices and are not blockchain/token-specific. This opinion is based on review of academic literature on cryptoasset valuation as well as analysis of data on historical returns of comparable assets. This evidence is reported in Section XI.

24. Based on the evidence presented in the preceding opinions, I conclude that TON blockchain and Grams share key similarities with other blockchain protocols and their native cryptoassets that have either been officially designated as commodities or have not been regulated as securities, such as Bitcoin, Ether, EOS, Siacoin, and Stellar Lumens. These features include blockchain architecture and decentralization, open source development, intended economic uses, and determinants of value accrual. I summarize the similarities in the Conclusion, Section XII.

V. BACKGROUND

25. In its lawsuit against Telegram Group Inc. and TON Issuer Inc, the U.S. Securities and Exchange Commission ("SEC") alleges that Grams, which are the native asset of TON, are securities. This report provides an economic analysis of Grams along a variety of dimensions, as described in the Summary of Opinions. This section describes the concepts of blockchains and cryptoassets, and why they are important for economic activity.

A. What is a Blockchain?

26. Fundamentally, a blockchain is a ledger. The concept of ledgers dates back millennia to clay tablets in Mesopotamia and ledgers are integrated throughout society today. Bank statements, medical charts, inventory logs, and real estate records are but a few examples of ledgers. Ledgers are a mechanism that society uses to reach consensus and agreement about a set

of facts. If a ledger is trusted, it serves as the source of truth regarding the current and historical state of accounts, transactions, and/or events.

27. The key feature that differentiates blockchains from other ledgers is the method by which the ledger is maintained. Most ledgers today are centralized, meaning they are maintained by a single entity. Examples include a bank maintaining a ledger of a customer's balance of currency, a manufacturer maintaining a ledger of output, or a private corporation maintaining a ledger of stock ownership. In contrast, blockchain ledgers are decentralized and distributed, meaning the ledger is maintained by multiple parties, often referred to as validators, miners, and/or nodes. These parties manage and operate the blockchain network. Transactions are grouped together over some time interval and posted to the ledger in "blocks," and each block is cryptographically linked to the previous block, creating an unbroken chain of valid transactions, hence the term blockchain.

28. Decentralization is important for a variety of reasons. First, it eliminates the existence of a central point of failure, thereby generating ledgers that are more resistant to manipulation or control by a single party. Second, it reduces the ability of centralized parties to extract rents from users of the ledger. Finally, it incentivizes broad based participation by third party software developers to create applications that utilize the ledger and expand its functionality.[2]

29. In the case of the TON, duties related to maintenance of the ledger are also performed by decentralized actors described as nominators, collators, and fishermen. I defer a more detailed description and analysis of these various actors to Section VII.

30. Blockchain ledgers record wallet addresses (i.e. accounts) and the balance of unspent native asset in each account. In the case of the Bitcoin protocol, this is essentially the only

[2] See: https://onezero.medium.com/why-decentralization-matters-5e3f79f7638e

functionality. More recent protocols, such as Ethereum and EOS, add a feature known as "smart contracts" allowing for a vastly richer set of use cases that require computation.

31. A smart contract is software code that has dominion over the value to be exchanged and executes an outcome automatically based on a set of pre-specified conditions (McKeon and Schloss, 2019). Many smart contracts can be thought of as "if-then" statements that control the movement of value. Most financial transactions are conditional, so smart contracts have nearly endless applications. Smart contracts can act as a digital escrow ensuring that conditions are met by all parties. A few examples include:

a. Releasing payment to the seller of a good, if proof of shipment is submitted.

b. Releasing custody of the share of stock to the buyer, if proof of payment is verified, or stated in reverse: releasing payment to the seller of stock, only if custody of the stock is released.

c. Regulating the transmission of non-financial information, such as identity attributes required for regulatory compliance: (e.g., allowing the transfer of the private security, only if the buyer submits proof that they are accredited).

32. Additionally, smart contracts can be used to create new assets to be tracked by the ledger separately from the main native asset. In protocols that include smart contracts, the ledger is recording not only accounts and balances, but also the state of the contracts.

B. What is a Cryptoasset?

33. Cryptoassets are units of account that are native to blockchains. The Taxonomy section of this report provides more specificity with regards to distinctions between different types of blockchain based assets, but while the terms "cryptocurrencies" or "cryptoassets" are often used interchangeably, in this report I use "cryptoassets" to refer to the general asset type, and

"cryptocurrencies" to refer to cryptoassets that are used to store value or as a medium of exchange. Bitcoin was the first decentralized cryptocurrency and is the largest by market capitalization, approximately $130 billion as of this writing.

34. A key feature of cryptocurrencies is that they do not require a central authority, rather, the architecture of the software facilitates the operation of the network by a decentralized set of actors. This differentiates them from national fiat currencies that are issued and managed by central banks. Fiat currencies can also be digitized, but the transfer of fiat currencies is typically intermediated by third parties such as the banking system. In contrast, the transfer of cryptocurrencies can be facilitated solely by software, removing third party intermediation from the transaction.

35. Ownership of cryptocurrency is proven through possession of "private keys." In laymen's terms, a private key is similar to a password. Users store private keys in a "digital wallet." In layman's terms, digital wallets are conceptually similar to a bank account, where you keep a balance of currency, but are fundamentally different than bank accounts because a digital wallet is simply a piece of software and custody of the assets remains with the user rather than a third party. In this sense, they are more similar to a billfold that contains units of fiat currency (i.e. cash).

36. It is important to understand that cryptocurrencies are not an electronic layer on top of our existing legacy financial system—they are a completely parallel system for recording and transferring value and ownership. As such, cryptocurrencies possess functionality with regards to electronic transmission of value that is not easily replicated within the systems that administer transmission of value via fiat currencies.

C. Why Blockchains and Cryptoassets are Important for Economic Activity

37. The importance of blockchains boils down to trust. The concept of trust is a critical component for economic trade. Arrow (1972) states (p.357) "Virtually every commercial transaction has within itself an element of trust," further considering the possibility that exchange requires, or is at least greatly facilitated by, a variety of virtues such as trust. Ackerlof's (1978) famous Market for Lemons paper offers another example of how markets suffer when participants cannot credibly determine quality and lack trust.

38. The institutional mechanisms currently used to produce trust largely grew out of the first wave of industrialization in 1840-1920. Zucker (1986) studies the shift in trust producing mechanisms during this period in the United States economy and finds that transactions prior to 1840 were largely based on trust engendered by cultural similarities and repeated interactions. However, the advent of the steam engine led to societal level changes in the ability of both people and goods to move great distances. These changes caused market participants to be more heterogeneous and substantially dropped the cost of transacting beyond local markets, both of which required innovation around the mechanisms by which society produces trust in economic exchange. This led to the rise of institutions, including banks, insurers, ratings agencies, and financial regulation. These mechanisms for trust production largely remain in place today.

39. Over the last twenty years, digitization and the internet have generated another technological shock to market activity. Digital goods, labor, and assets can now be transferred electronically to anywhere on the planet at trivial cost, akin to the shock to market depth and heterogeneity that we witnessed at the advent of the railroads and steam ships. This puts strains on nearly all methods of trust production we use today. Regulation is more challenging, because regulation is typically carried out at the national or state level, whereas digital commerce often

transcends political boundaries. Additionally, digital commerce puts strains on intermediaries such as banks because payment systems are not fully interoperable and ledgers that aren't interoperable must be reconciled, placing them at a disadvantage in terms of both speed and cost.

40. Blockchains fundamentally alter the cost structure and nature of trust production, which promises to have wide ranging impacts on economic activity. Banks and consulting firms are cognizant of the changing landscape and researchers at these organizations have published numerous reports outlining their views on the impending disruption by blockchains and cryptoassets. Excerpts include:

41. *"Blockchain is changing the face of business today. It is pushing the boundaries of what is possible, allowing dynamics between businesses and consumers that were previously unimaginable because of the immutability of shared data transacted broadly across an ecosystem of multiple parties. Right now, someone, somewhere, is creating a blockchain solution to drive innovation and disruption of traditional business models. This is occurring in virtually every industry and in most jurisdictions globally. Indeed, we are now witnessing an evolution in commerce."* – Deloitte[3]

42. *"A new technology is redefining the way we transact. If that sounds far-reaching, that's because it is. Blockchain has the potential to change the way we buy and sell, interact with the government and verify the authenticity of everything from property titles to organic vegetables. It combines the openness of the internet with the security of cryptography to give everyone a faster, safer way to verify key information and establish trust."* – Goldman Sachs[4]

[3] See: https://www2.deloitte.com/content/dam/Deloitte/us/Documents/noindex/us-cons-deloitte-blockchain-inspiring-an-evolution-in-commerce.pdf, p.3.
[4] See: https://www.goldmansachs.com/insights/pages/blockchain/index.html

43. *"As we look to the decade ahead, it would not be surprising if a new and mainstream cryptocurrency were to unexpectedly emerge... The question is which country will take advantage of being the first to obtain licenses and build alliances. As that occurs, the line between cryptocurrencies, financial institutions, and public & private sectors may become blurred."* – Deutsche Bank[5]

44. *"Based on the observations of survey participants and the innovations and seeds of change that are already emerging in the market, we foresee a coming wave of real-asset tokenization that will allow investors to participate financially in both the cash flow and asset appreciation of a whole variety of hard assets."* – Citi[6]

45. In sum, blockchains and cryptoassets facilitate types of digital commerce that are cost prohibitive or functionally challenging with fiat currency.

46. One example is micropayments, which refer to very small transactions that are less than $1 and can be as low as fractions of a cent. These payments are infeasible via most traditional value transfer systems that use fiat currency, however, cryptocurrencies may drive transaction costs close to zero. Applications include payments for any good or service that is streaming in nature, such as video content, or electricity. Micropayments also enable goods or services that are consumed by a very high volume of users at very low cost, such as millions of video game users paying a few cents each to an open source software developer that is creating a new feature.

47. Another example is the promise to facilitate near instantaneous global settlement of asset transfers such as stocks, bonds, and real estate. Many of these assets are challenging to access outside their home jurisdiction due to regulatory compliance costs, but blockchain based

[5] See: http://dbresearch.com/PROD/RPS_EN-PROD/PROD0000000000503196/Imagine_2030.pdf, p.60.
[6] "Industry Revolution Series Part I: The New Building Blocks: Moving Beyond Equities and Bonds, The Emergence of Robo-Beta & Democratizing Access to New Alpha Sources." Citi Business Advisory Services, 2018., p. 34.

identity solutions may ease the burden of know your customer and anti-money laundering reporting requirements, thereby opening up markets to a much wider set of participants.

48. Blockchains such as TON will compete for these use cases and many more that are detailed in Section IX. Based on my research and experience, my opinion is that we are at a nascent stage in terms of the long run impact of blockchains and cryptoassets on the global economy, and that U.S. citizens stand to benefit immensely from access to these technologies.

VI. GRAMS WILL BE MOST CONSISTENT WITH THE CRYPTOCURRENCY AND UTILITY TOKEN CATEGORIZATIONS

A. Overview of TON and Grams

49. In the case of the TON blockchain, the native asset is called Gram, much like Ether is the native asset of the Ethereum blockchain. They serve as the unit of account on the primary chain of the protocol.

50. Grams are designed to be a multi-purpose cryptocurrency that addresses problems with currently available alternatives such as Bitcoin and Ether. Specifically, Grams are designed to be able to scale to billions of users without the congestion that has plagued other networks, while maintaining decentralized management of the network. Marketing materials indicate that the limitations of alternative cryptocurrencies was a primary motivation for the development of TON, as none of the existing cryptocurrencies were viewed as viable for deployment to the hundreds of millions of users of the Telegram Messenger application.[7]

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[7] 2018 Stage A Primer (TG-003-00000056), p. 3.

51. TON is designed to eventually include numerous assets other than Grams, however, Gram holders will be uniquely able to participate in validation and governance of the network. In addition, participants will be able to use Grams as a medium of exchange for a variety of consumptive use cases.

52. Further, TON is more accurately described as a "blockchain of blockchains" in the sense that the design consists of a masterchain as well as subsidiary workchains, and shardchains.[8] To abstract from the technological specifics, they can be thought of collectively as ledgers that are jointly maintained by the validator set to generate the desired outcome: a trusted source of truth about the state of accounts, transactions, and contracts within TON.

53. Although the blockchains are the centerpiece of TON, a variety of other components exist as part of the technology stack. They are introduced briefly here and covered in more detail in the section on economic uses of Grams.

54. Beneath the blockchains (and all other components) is the TON Networking layer. A simplified description is that the networking layer facilitates rapid information exchange among the other components of the system. A more detailed description of the networking layer is found in the TON White Paper and will not be reproduced in this report. As I understand based on my review of the case materials, the development is complete and the layer is fully functioning as intended on the test network.

55. Several other components, which sit alongside or on top of the TON blockchain in the technology stack are also anticipated to be functional at network launch. While these

[8] Shardchains, which originates from database terminology of "sharding", contain only a portion of the blockchain data and are designed to reduce the processing power requirements and increase the scalability.

components aren't essential to the core functionality of the TON platform, they may be viewed as "nice-to-have" features. Brief descriptions are as follows:[9]

a. TON Payments: a platform for micropayments;

b. TON Services: a platform for third-party services on the TON Blockchain that provides user-friendly interfaces for decentralized applications and smart contracts;

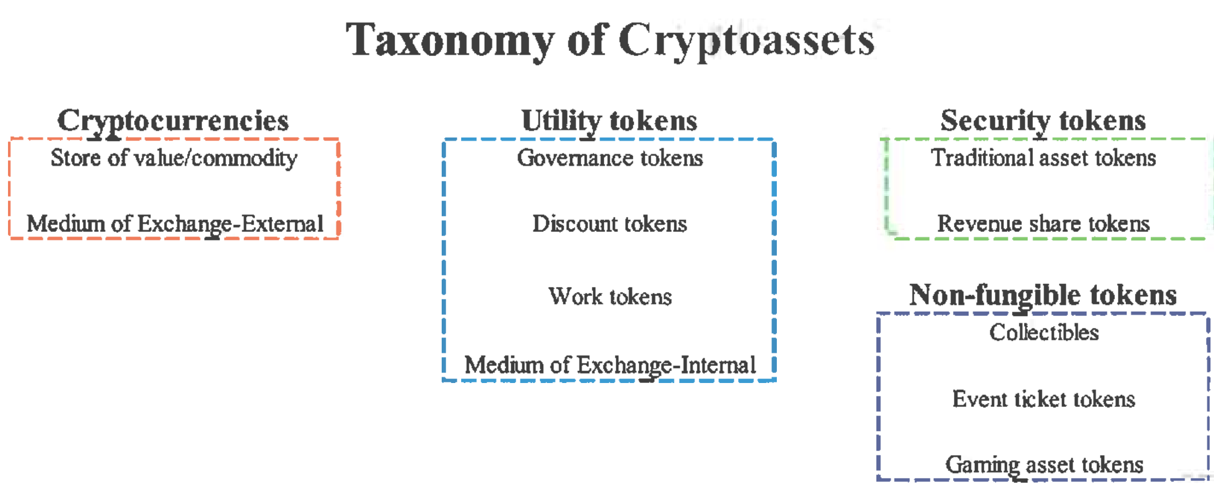
c. TON Storage: a distributed file-storage technology for storing files and large amounts of data;

d. TON Proxy, a network proxy/anonymizer used to safeguard the identity and IP addresses of TON nodes;

e. TON DNS:[10] a service for assigning human readable names to accounts, smart contracts, services and network nodes;

B. Taxonomy of Cryptoassets

Figure 1: Taxonomy of cryptoassets



[9] Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, No. 5, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019).
[10] DNS stands for Domain Name System.

56. Economic analysis of cryptoassets, such as Grams, depend critically on the characteristics of the asset itself, which determine how it will be used. In Figure 1, I construct a broad taxonomy of cryptoassets containing four categories: Cryptocurrency, utility tokens, security tokens, and non-fungible tokens. The lines between these categories are not clear cut and they are not mutually exclusive with regards to a particular asset, because many assets, including Grams, are designed to have multiple functions. I provide a brief description of each category below.

57. The most famous example of cryptocurrency is Bitcoin. From an economic standpoint, cryptocurrencies most closely resemble fiat currencies or commodities. As such, Bitcoin is regulated by the US Commodity Futures Trading Commission (CFTC) in the U.S., not the SEC. Cryptocurrency uses include making payments for a wide range of goods and services, akin to fiat currencies like the U.S. Dollar, and storing value, akin to commodities like gold. Exchange rates between different fiat currencies, or between commodities and fiat currencies, are market outcomes where market participants include both speculators and users. Sources of value and price determinants are explored in more detail in Section XI.

58. General purpose cryptocurrencies can be used to pay anyone willing to accept them. In contrast, utility tokens are used primarily for payments and other purposes that are specific to a particular blockchain network. Consider the example of data storage. Sia is a decentralized network for data storage where a user stores files on a distributed network of hardware owned by many different participants. In other words, the Sia blockchain is effectively a technology that facilitates a marketplace for data storage. Siacoins are the native asset on this network and are used as the medium of exchange to buy and sell file storage service. While nothing prevents a holder of Siacoins from using them to buy other goods or services, they are designed primarily to

provide utility within their own network. Siacoins are utility tokens and have not been regulated by the SEC as securities.

59. Additional types of utility tokens enable functionality beyond payments. These might include governance rights related to network operations, the right to a perpetual discount on a good or service, or the right to contribute work to the network (e.g., the right to validate transactions).

60. Security tokens are those in which a blockchain is used to maintain a record of ownership claims on financial assets that are similar to traditional securities and which are regulated by the SEC in the United States. An example is a blockchain token that represents a share of stock in a corporation, or a bond issued by a municipality. The value of the token is typically a function of expected future cash flows generated by the issuer. As such, disclosures by the issuer, which are mandated by securities laws, are relevant to purchasers because the issuer is operating the entity responsible for generating the cash flows and their financial condition is a determinant of future cash flows.

61. Decentralized cryptocurrencies, such as Bitcoin and Ether, are not considered security tokens because these cryptocurrencies are operated by a decentralized set of actors and operations continue even if the progenitor ceases participation. In fact, this is exactly what happened with Bitcoin—the creator, Satoshi Nakamoto, left the project in April 2011, a little more than two years after the network was launched.[11] Since operations are decentralized and any participant is free to enter or exit at will, disclosure of their financial condition is less relevant.

62. Finally, non-fungible tokens are those in which every token is able to be uniquely identified. Use cases include tracking ownership of collectibles like digital art, or tokens

[11] See: https://bitcoin.stackexchange.com/questions/28108/satoshis-final-statement

representing reserved seat tickets to a sporting event. Price is determined on a case by case basis for each and every token, much like price is determined for every Picasso painting on a case by case basis. Similarly, tokens granting access to courtside seats at a basketball game would be priced differently than tokens for seats in the upper deck.

C. How Grams Fit into the Taxonomy of Digital Assets

63. Use cases for Grams are analyzed in detail in Section IX of this report. For the purposes of taxonomy classification, I summarize them here. Once TON Blockchain is launched, and Grams are issued, their use cases are described to include:[12]

a. Payment for physical and digital products and services.

b. Commission ("gas") paid to TON validators for processing transactions and smart contracts.

c. Stakes deposited by validators to process transactions and generate new blocks and Grams.

d. Capital lent out to validators in exchange for a share of the processing reward.

e. Voting on parameters of the protocol.

f. Payment for services provided by dApps[13] on the TON Blockchain (TON Services).

g. Payment for data storage via the platform (TON Storage).

h. Payment for registering domain names on the TON Blockchain (TON DNS) and hosting sites (TON WWW).

i. Payment for virtual private network services via the platform (TON Proxy)

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[12] Ex. G to Waxman Declaration – 2017 Primer, p. 14.

[13] dApps stands for decentralized applications.

64. Based on the use cases described above in TON's marketing materials, my opinion is that once the network is launched, Grams fall into both the cryptocurrency and utility token categories.

65. Use case #1, payments for goods and services, is consistent with a general use cryptocurrency for commerce.

66. Use cases #3 and #4, validation staking and lending to validators, is consistent with a work token, which is a subset of utility tokens.

67. Use case #5, voting, is consistent with a governance token, which is a subset of utility tokens.

68. Use cases #2, 6, 7, 8, and 9, payments for computation, TON Services, TON Storage, TON DNS and TON Proxy, are consistent with payments for platform specific goods and services, which is a subset of utility tokens.

D. Overview of Digital Asset Markets

69. Once a cryptoasset is launched, new users can acquire the asset in one of two ways: <u>Purchase</u> through a trading venue or directly from the protocol, or <u>earn</u> by providing a service, selling a good, or performing an action.

70. The development of a new blockchain network is often financed by purchasers that provide capital well in advance of network launch. They may be motivated by the prospect of investment returns from price appreciation and/or an intention to use the resultant cryptoasset for utility purposes such as providing validation services.

71. Once the network goes live and the native asset is distributed to early purchasers, they are able to sell the assets on secondary markets, where it becomes feasible for consumers to purchase the assets in smaller quantities that are consistent with a wider variety of consumptive

uses. Consumers wishing to purchase Grams will need what is referred to colloquially as a fiat on-ramp. This is typically a trading venue that accepts fiat deposits such as Coinbase, but alternative methods include a peer-to-peer transaction, or cryptocurrency ATMs. An alternative to converting fiat directly to Grams is to use fiat to purchase a cryptocurrency that serves as common trading pair such as bitcoin, ether, or tether, and then execute a second trade to convert into Grams.

72. In order to facilitate purchases for consumptive uses, it is important that the asset is listed at trading venues accessible by consumers. For example, Coinbase is one such venue, and based on the fact that Coinbase Custody has announced that they intend to support Grams, it is plausible that they will also list Grams on their exchange after mainnet launch, conditional on the outcome of this litigation[14].

73. There is considerable variation in secondary market trading venues for cryptoassets in terms of structure (centralized versus decentralized), number of trading pairs, acceptance of fiat deposits, regulatory compliance, and location/jurisdiction (Benedetti, McKeon, and Pfiffer, 2019). Similar to markets for commodities, cryptoasset market participants consist of both consumers and speculators. The presence of speculative purchasers in the market for an asset does not signify that the asset is a security. Financial speculators are a common feature in markets for all types of assets such as fiat currencies like U.S. Dollars or Euros, and consumptive commodities such as grains or crude oil.

74. Listing decisions at trading venues are largely driven by expected trading volume. Venues do not need to interact with, or gain permission from, the issuer or core developers in order

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[14] See: https://blog.coinbase.com/coinbase-custody-to-support-telegram-open-network-grm-solana-sol-orchid-oxt-2a489c162fad

to list the asset. In the case of centralized exchanges, they simply need to acquire a digital wallet compatible with the asset.

75. In addition to purchasing cryptoassets through a trading venue, users can also earn them. A common way to earn cryptoassets is by providing validation services. In the early days of Bitcoin, operating as a bitcoin miner was effectively the only way to acquire units of the cryptocurrency, similar to the way validators will earn additional units of Grams in TON's PoS system. Today, one might also earn cryptocurrency in exchange for labor, by selling a good, or by performing an action such as watching an ad or installing a piece of software such as a digital wallet.

76. As retail consumers gain access to the asset after mainnet launch, the number of wallet addresses that hold the asset tends to rise, particularly those that hold small amounts of the asset. For example, Figure 2 reports the percentage of wallets that held various amounts of EOS as of two points in time—as of the writing of this report and the prior year. Figure 3 reports the same metric for ETH. The number of wallets is not the same as the number of users, because a single user can create more than one wallet address, but Figure 2 shows that the vast majority of wallets held amounts less than 1,000 EOS and Figure 3 shows the vast majority of wallets held less than 10 ETH, which may be consistent with consumptive uses rather than investment purposes (EOS is trading at about $2.57 per token and ETH is trading at about $128 per token at the time of this writing).[15]

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[15] Data Source: https://coinmarketcap.com/

Figure 2: Distribution of EOS Wallet Addresses by # of Tokens[16]

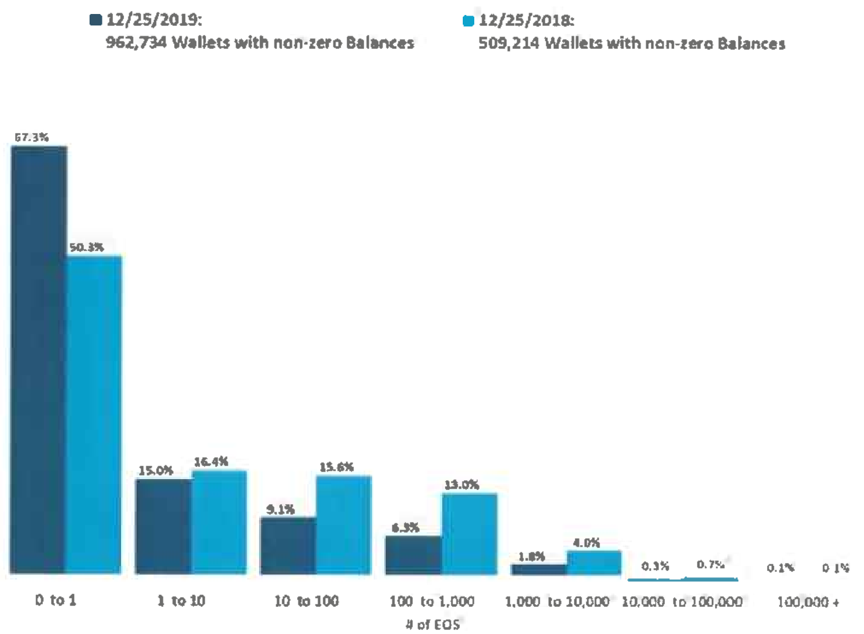
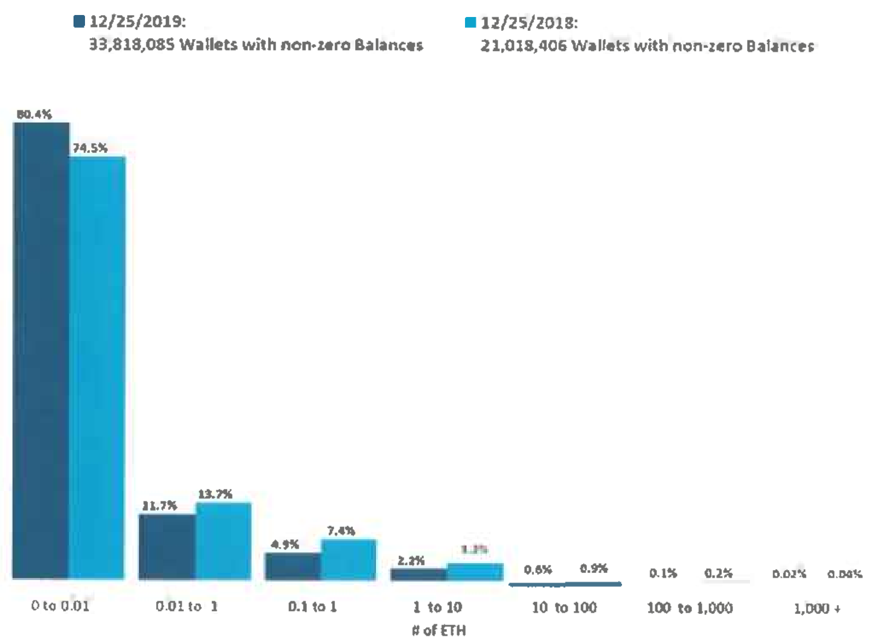


Figure 3: Distribution of Ethereum Wallet Addresses by # of Tokens[17]

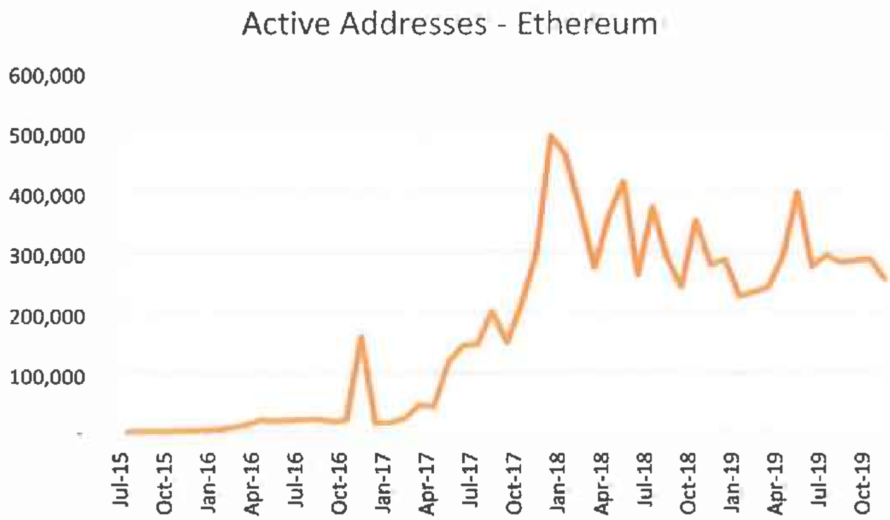


[16] Data Source: https://www.eossnapshots.io/?

[17] Data Source: https://github.com/blockchain-etl/awesome-bigquery-views#every-ethereum-balance-on-every-day

77. The number of active addresses also tends to rise after mainnet launch. Active addresses are a metric used by market participants to assess network activity. Figure 4 reports the time series of active addresses in Ethereum. At launch, there were 424 active addresses (July 2015), rising to 21,395 one year after launch (July 2016), and 255,240 as of November 2019.

Figure 4: Ethereum Active Addresses



VII. TON BLOCKCHAIN CONSENSUS AND GOVERNANCE

78. A public blockchain ecosystem typically consists of the following categories of participants: core protocol developers and/or ecosystem foundation, validators, application and services developers, and users.

79. These constituencies are not mutually exclusive, with individuals or entities often falling into multiple categories. In this section, I focus on validators because they collectively provide the most essential management function of a blockchain: processing transactions and posting them to the ledger.

80. Validators are compensated for performing work via two mechanisms. First, they can earn a reward from the protocol, which is a small amount of new cryptoasset minted or disbursed as compensation for posting a block of transactions. Second, users can include a transaction fee as additional compensation above and beyond the block reward. In some cases, including a high transaction fee will incentivize validators to post your transaction more quickly.

81. In order to achieve consensus regarding the validity of transactions within a block, an algorithm must exist that makes it difficult for adversarial validators to post invalid blocks. Below, I review the two most widely deployed categories of consensus algorithms: Proof of Work ("PoW") and PoS.

A. Proof of Work Versus Proof of Stake

82. Within PoW consensus mechanisms, the cost borne by the validators is compute power (which translates to electricity and hardware expense). In order to post a block of transactions to the ledger, the miner must also submit a solution to a puzzle and this puzzle requires computation to solve. The amount of power a piece of hardware possesses to solve these puzzles is called hash power. Collectively, the aggregate hash power on a network is referred to as the network's hash rate and as it increases then the difficulty of the puzzles (and hence the required computation to solve them) increases as well. The cost of required computation is what makes the blockchain secure and tamper resistant, allowing one to trust the contents of the ledger even if they don't trust all of the participants in the network.

83. PoW has proven to be largely resilient to adversarial miners, and it is the consensus algorithm used by the two most valuable blockchain networks in the world, Bitcoin and Ethereum. However, it faces meaningful challenges, specifically, resource consumption and scalability. A substantial amount of electricity is consumed to process a relatively small number of transactions

on the Bitcoin network because many miners are simultaneously competing to solve the same puzzle. As of this writing, the Bitcoin network consumes approximately the same amount of electricity as the country of Colombia on an annual basis. Some would argue that much of the electricity dedicated to Bitcoin is excess generation, but the fact remains that PoW blockchains are resource intensive.

Figure 5: Country Ranking[18]

84. A second challenge in PoW is scalability. The Bitcoin network is capable of processing a maximum of seven transactions per second ("TPS") on average (Croman et al., 2016) and Ethereum's throughput is approximately 15 TPS. In contrast, VISA reports a peak throughput of 56,000 TPS. Bitcoin and Ethereum, as currently constructed, are not equipped to handle mass adoption.

85. A variety of solutions to the scalability challenge have been developed, and PoS is one such solution. Broadly, the economic cost borne by the validators in PoS is the risk of losing the capital they have staked to participate in the validation process. Work is typically performed by a single validator for each block, vastly reducing resource consumption and substantially

[18] Image Source: Cambridge Center for Alternative Finance.

increasing throughput. Consensus is reached through a voting mechanism among validators. The specifics of the consensus mechanism in the TON blockchain, which uses a variation of the PoS consensus algorithm, are discussed below.

B. TON's Byzantine Fault Tolerance Proof-of-Stake Consensus Protocol

86. To ensure high scalability of transaction flow in the TON ecosystem, TON blockchain is built on a variant of PoS consensus protocol called Byzantine Fault Tolerance ("BFT PoS"). Under such protocol, certain nodes function as validators by confirming and reporting the state of the blockchain truthfully to the rest of the network. Validators maintain a full copy of the blockchain and are identified by their public keys.[19] They take turns proposing blocks at each new block height. There is at most one proposer per voting round. Each proposal is signed by a validator's corresponding private key so that the validator responsible for it can be identified if some failure were to occur. The rest of the validators then vote on each proposal, signing their votes with their private keys. In a single round of voting, a transaction block is appended to the blockchain ledger only if it is approved by the supermajority of the validator set, i.e. by at least 2/3 +1 of the validator nodes.

87. Under the PoS algorithms, including its BFT variant, users have to stake and lock a certain minimum amount of the native blockchain currency for a certain period of time in order to become validators. Their rewards for the time and effort committed to truthful transaction validation are proportional to the amount of the protocol token staked. To prevent validation of malicious transaction blocks and any potential collusion between validators in doing so, validators' coin stakes are automatically slashed if malicious activity is detected. Fishermen, a decentralized

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[19] As the blockchain grows, it is contemplated that TON Storage will act as an archive so that validators need only keep two months of activity.

set of actors tasked with detecting malicious activity within TON, are discussed in more detail below.

88. In light of the advantages around speed and scalability, several blockchain networks have chosen PoS, of which there are several variants, rather than PoW. For example, the EOS blockchain is based on Delegated Proof of Stake (DPoS),[20] and the Stellar network is designed around a version of PoS protocol called Federated Byzantine Agreement.[21] Ethereum, which was launched and currently operates as a PoW blockchain, is actively working on a migration to PoS, which some observers believe will increase decentralization of the validator function.

C. TON Block Validators

89. As in any PoS blockchain designed to ensure high transaction count and fast processing speeds, a TON validator operation is not a trivial activity, and it requires considerable disk space, computing power, network bandwidth, as well as a continual commitment to 100% uptime.[22] The specifications of the TON blockchain require that validators use high-performance (multi-processor) servers with good network connectivity and a sufficient amount of accessible memory.[23], [24] A TON validator may be in multiple validator subsets and is expected to execute validation/consensus algorithms in parallel.

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[20] Grigg, Ian, "EOS: An Introduction". July 5, 2017, p. 3. See: https://iang.org/papers/EOS_An_Introduction-BLACK-EDITION.pdf

[21] Mazieres, David. "The Stellar Consensus Protocol: A Federated Model for Internet-level Consensus." February 25, 2016., p. 1. See: https://www.stellar.org/papers/stellar-consensus-protocol.pdf

[22] Under the BFT POS protocol, if 1/3 or more of active validators are off-line, the entire network may halt due to its inability to form a voting supermajority required for the validation of a given transaction block.

[23] TON White Paper, p. 45.

[24] According to TON technical documents, one cannot mine new TON coins on a home computer or a smart phone due to relatively high technical requirements. But this is increasingly not different from PoW cryptocurrencies like Bitcoin, where token mining has become increasingly dominated and centralized by mining pools using specially designed and expensive mining computer hardware.

90. The TON blockchain distinguishes between block validation on the masterchain and the shardchains. On the masterchain, there is a global set of nodes/validators which deposit stakes of Grams to be eligible for new block generation and validation. The global set of validators is elected approximately once each month and is universally known one month in advance. The stakes of the validators are frozen until one month after the end of the period for which they have been elected, to allow for *ex post* settling up in case new disputes arise. Approximately one month after their validation period has concluded, the stakes are returned, along with the validator's share of validation rewards and fees from transactions processed during this time.

91. In addition to validating transactions on the masterchain, validators must also be available for the purpose of validating blocks on any shardchain. For shardchains, there is a smaller subset of validators, known as task groups, chosen from the global set, who are assigned in a pseudo-random way, rotated every hour and known one hour in advance.[25]

92. According to the documents that I have reviewed, the minimum stake required for a node to become a validator and to perform time- and resource-consuming validation functions, is estimated to be at least 100,001 Grams.[26] A list of potential TON validators at launch is provided in Exhibit 2 of this report.

D. TON Blockchain Nominators

93. In addition to block validators, TON blockchain design introduces other consensus-enabling parties: nominators, fishermen and collators. Nominators are participants that may lend their Gram holdings to validators in return for a proportional share of the staking reward earned

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[25] TON White Paper, p.10, 48.

[26] See: https://test.ton.org/Validator-HOWTO.txt

by the validator. Effectively, nominators "vote" for validators by lending them Grams but they also share the risk of the chosen validator's performance.[27]

94. In summary, the built-in nominating procedure on the TON blockchain enables a user to participate in validation without large holdings of Grams. In essence, it is designed to prevent either large Gram holders or existing validators from monopolizing the power to determine validator sets, increasing decentralization within the system.

95. A wide range of service providers exist to manage the technical aspects of validation for users. Exhibit 3 lists companies that offer staking and validation services on other PoS blockchains. Based on my experience, I conclude that some of these providers are likely to offer staking services to Gram holders upon mainnet launch.

E. TON Blockchain Fishermen

96. Fishermen is another category of participants on the TON blockchain who can participate in the transaction block validation process and receive compensation for this participation without being a validator and thus avoiding the relatively large stake of Grams required for a validating node. Any node can become a fisherman by making a small deposit in the masterchain.

97. According to the TON White Paper, fishermen can publish an invalidity proof of a block, which were previously signed and published by validators. If other validators agree with this invalidity proof, the offending validators are punished (their stakes are slashed), and the fisherman obtains some reward in the form of a fraction of coins confiscated from the offending validators. Thus, fishermen can be thought of as a decentralized set of actors that police the validators. For practical purposes, a natural candidate to become a fisherman would be a validator

[27] TON White Paper, p. 45-46.

who is ready to process new blocks, but who has not yet been elected as a validator, for example, because of their inability to deposit a sufficiently large Gram stake.[28]

F. TON Blockchain Collators

98. In order to produce high scalability and fast transaction speeds, and to lessen the computational and storage burden on the validators, the TON blockchain provides yet another way to decentralize the participation in the block validation process: collators. A collator node is a node that prepares and suggests to a validator new block candidates on a shardchain. The collator function effectively outsources part of the validation procedure to collators. The benefit of such outsourcing is that a validator does not need to watch the state of the neighboring shardchains, but instead can easily check the proposed block candidate for validity, without having to download the complete state of a particular shardchain or a set of related shardchains. [29] In return for its work to submit new (collated) block candidates to a validator, a collator receives a portion of the validation reward of the validator, or gets paid directly by users via micropayment channels for the inclusion of their transactions.[30]

VIII. TELEGRAM IS A PARTICIPANT IN THE OPEN SOURCE NETWORK, NOT AN ESSENTIAL MANAGER

99. TON is designed to be open source, meaning that the underlying software code that dictates how the blockchain functions is freely available. Anyone can replicate the code and anyone can build applications and services within the ecosystem. Open source software

[28] TON White Paper, p.10, 46.
[29] *Id.*, p. 47.
[30] *Id.*

developers are driven by a variety of incentives, some of which are non-pecuniary. I describe the motivations for open source development efforts below.

A. Academic Literature on Open Source Development

100. Lerner and Tirole (2002) outlines several reasons why a programmer with significant opportunity costs would choose to contribute to an open source project without monetary compensation. Lerner and Tirole (2002) break the incentives faced by a programmer into two parts: immediate benefits and delayed rewards.

101. Programmers have two immediate benefits to working on open-source software. First, programmers become more skilled by engaging with the open source community. Open source development exposes programmers to new techniques and methods, allowing them to experiment without the costs of failure typical in formal employment. Second, programmers may derive non-pecuniary benefits from working on an open-source project they deem interesting and important.

102. In the long-term, programmers are subject to two primary motivations. First, open-source development can lead to job offers or equity in commercial open-source based firms. Second, a long history of development can lead to a reputational effect that Lerner and Tirole (2002) refer to as the ego gratification effect. Both are categorized as signaling incentives.

103. Signaling incentives are strong when:

a. The work is more visible – larger or flashier projects yield higher signaling utility.

b. The work is easier – projects with lower marginal effort are more attractive.

c. The work is more informative about talent – projects that are more complex indicate a programmer's skill.

104. A section of Lerner and Tirole (2002) that is germane to TON is that of organization and governance of an open-source project. They state (p. 221):

105. *"The initial leader must also assemble a critical mass of code to which the programming community can react. Enough work must be done to show that the project is doable and has merit. At the same time, to attract additional programmers, it may be important that the leader does not perform too much of the job on his own and leaves challenging programming problems to others. Indeed, programmers will initially be reluctant to join a project unless they identify an exciting challenge. Another reason why programmers are easier to attract at an early stage is that, if successful, the project will keep attracting a large number of programmers in the future, making early contributions very visible."*

106. The strategies of commercial entities to participate in open source are described in Lerner and Tirole (2002). One such strategy is for a firm to support a project where the open source community fails to provide adequate solutions, and to sell complementary products. Firms in this model are incentivized to subsidize the open source community, though to a limited degree as the firm only captures a portion of the gains to development.

107. Johnson (2002) develops a model where there is a population of developers, all of whom are aware of an improvement that can be made to an open source project. Each developer chooses whether to develop the feature for some personal cost. If the feature is developed, all developers receive some private valuation that varies from person to person. The key takeaway is that adding more developers increases aggregate welfare, as projects are more likely to generate surplus for all developers.

108. Abadi and Brunnermeier (2018) study the interaction of various participants on a blockchain, such as validators, developers, and users. Public blockchains that are open source are

optimal in the sense that record keepers cannot generally extract rents from platform users. Users who believe that a record keeper is not acting in their interests can choose to fork (or replicate with alterations) the blockchain. Because all data is perfectly transmissible, this is largely a costless action.

B. Third Party Development Activities in TON

109. According to a report by Electric Capital, the number of core developers for major blockchain protocols is relatively small compared to total developers, most of which are building applications and services.[31] It is apparent from my review of case documents and publicly available sources that TON has engaged in a concerted effort around third party developers to create additional functional uses of Grams. It is possible that the uncertainty imposed by ongoing litigation has deterred third-party development activities, but there is evidence, presented below, of substantial development efforts nonetheless.

110. For example, hackathons and contests are a common way to incentivize development of applications and services, as well as find bugs and refine the codebase in open source environments. On September 24, 2019, TON, via the official Telegram Contests account, announced the commencement of a contest for development activities on the TON Blockchain. Contestants were asked to (1) develop one of more smart contracts, (2) suggest improvements for FunC / TON Virtual Machine ("TVM") and (3) find issues and suggest fixes for TON Testnet. More specifically, the smart contracts developed for the contest fall under the following categories:

[31] As of January 2019, Ethereum had 99 active core developers, Bitcoin had 47 core developers and EOS had approximately 33. Some core teams on major protocols were even smaller such as Stellar and Bitcoin Cash at less than 10 each. See: https://static1.squarespace.com/static/5c745b19c2ff6174b1290e42/t/5c805a3ae4966b1ce3a2a937/1551915603922/The+Dev+Report.pdf

a. A multi-signature wallet – used for enhanced security, escrow transactions and decision making.

b. An automatic TON DNS Resolver – used to automatically register new subdomains.

c. A manual TON DNS Resolver – used to manually register new subdomains.

d. A synchronous two-party payment channel – used to facilitate the pooling of Grams for payment agreements between two parties.

e. An asynchronous two-party payment channel – used to facilitate the pooling of Grams for simultaneous multi-payment agreements between two parties.

111. Out of a total of 66 submissions, 41 were awarded a cash prize, with all prizes totaling $235,000. As evidenced from the contest requirements, TON's objective is to create a decentralized community of open source developers, for the construction and improvement of key components of the TON Blockchain, such as the TON Virtual Machine, TON DNS, and payment services, as well as assist in making the platform more robust and secure.[32]

112. In addition, TON has engaged in communications with numerous external parties regarding the potential development of applications and services for Grams on the TON Blockchain, including TON Labs, Gett, Achieve, DrimSim, Telefonica, Payfone, CryptoBazar, Beproducer, Everstake, Mercuryo, PrivatBank, KupiBilet, and WEBPAY.[33] Additional details on product development by third parties is found in Section IX.F. titled "Consumptive uses of Grams external to TON."

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[32] TON Contest.txt. See: https://web.telegram.org/#/im?p=@contest, September 24, 2019.

[33] Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, No. 3, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019).

113. The most active third-party developer on TON is TON Labs, founded in May 2018 and comprised of a decentralized team of developers, engineers and professionals. TON Labs is creating tools to make coding on the TON Blockchain easy and consequently facilitate application development as well as the creation of a developer community around the TON Blockchain. The purpose is to allow the developer community to create, deploy, distribute and manage TON-based blockchains for consumer and enterprise applications.

114. TON Labs has an official GitHub at: https://github.com/tonlabs. GitHub is a software development platform where contributors to open source projects can post and update source code. The TON Labs GitHub has 20 repositories, which are project organizers consisting of folder and files, each of which has numerous commits.[34] TON Labs has approximately 800 developers contributing to its repositories.

115. One of the most important projects by TON Labs is the TON Compiler Kit, which allows developers to compile smart contracts from languages other than those that are native to TON.[35] This toolkit is designed to shorten the adoption learning curve for developers in writing smart contracts for the TON Blockchain, as developers can reuse their current programming skills to create TON smart contracts and migrate code from their previous projects on Ethereum with only minor tweaks. Leveraging the development activity on Ethereum through smart contract compatibility will quickly and significantly increase the spectrum of economic uses of Grams. The TON-Compiler repository is the most active segment of the TON Labs GitHub, with over 296,000 commits as of December 23, 2019.[36]

[34] A "commit" is a change to the code within a repository. The number of commits is a measure of development activity.
[35] See: https://medium.com/@expathos/telegram-open-network-labs-releases-development-suite-for-ton-blockchain-895d13a9d9d0
[36] See: https://github.com/tonlabs/TON-Compiler

116. TON Labs is developing various other toolkits to allow developers to debug and test smart contracts in a controlled environment, and connect apps to TON using an open standard. Additionally, TON Labs provides documentation related to the development and implementation of smart contracts on the TON Blockchain. Finally, in April 2019, TON Labs announced a partnership with external vendor Wirecard to develop a joint digital financial services, payments and banking platform.[37] These efforts by TON Labs are designed to facilitate broad participation by third party developers in the TON open source ecosystem.

117. Further evidence of third-party developer activity on TON is found in a blog post, dated September 24, 2019 by token.store, a developer of decentralized exchanges: "*This will be the sixth blockchain ecosystem token.store has built on top of. We have never seen a developer community grow as quickly as TON's. We have never seen such an amount of high quality developer tools developed in such a short period of time.*"[38]

118. In summary, the open source nature of the TON blockchain protocol, as well as the ability, and evidence of, third-party developers to produce competitive applications and services suggests that Telegram is one of many participants in the system, as opposed to an essential manager.

C. Ecosystem Foundations and Open Source Development

119. Ecosystem Foundations, or organizations that fill similar roles, are a common component in several leading smart contract platforms similar to TON such as Ethereum, EOS,

[37] See: https://www.wirecard.com/company/press-releases/wirecard-and-telegram-open-network-infrastructure-developer-ton-labs-enter-partnership

[38] See: https://medium.com/token-store/thoughts-on-telegram-open-network-ton-teams-timing-traction-economics-uncertainties-eca6396b1549

and Stellar. These foundations often contribute to open source development by funding projects by third party developers and/or contributing to core protocol development.

120. In the case of TON, approximately 28% of the total initial supply of Grams will be held in TON Reserve. If the TON Foundation is launched, its role is described as being limited to the following three activities: (1) selling Grams through the TON Reserve; (2) awarding Grams from the Incentives Pool; and (3) publishing non-binding opinions and research results regarding the TON Blockchain's development and policy[39].

121. Neither the TON Reserves nor the incentive pool will be staked for validation purposes, meaning they will not participate in the primary operation of the network. I provide analysis of foundations at comparable projects below.

1. EOS/Block.one

122. The EOS blockchain does not have a foundation, but the issuer, Block.one fills a similar role. Block.one is estimated to hold approximately $240 million of EOS as of December 4, 2019. In contrast to the TON Foundation, Block.one recently announced it plans to take an active role in the validation process by participating in block producer voting.[40]

123. EOS has run several hackathons in recent years, similar to TON Contests described in the previously section.[41] Additionally, the model for funding development employed by Block.one is different from the grant model of the TON Foundation and the Ethereum Foundation, in that Block.one follows a venture capital model in addition to grants. Block.one's $1 billion venture fund, EOS VC, is actively investing in companies that are developing dApps on the

[39] Telegram Group Inc. Fourth Supplemental Memorandum to the Staff of the SEC (July 25, 2019).
[40] See: https://block.one/news/blockone-to-begin-voting-for-eos-public-blockchain-upgrades/
[41] See: https://hackathon.eos.io/

network.[42] By disbursing capital in the form of investments rather than grants, EOS VC may be in a position to exert controlling and managerial direction in these projects. As of the time of this writing, Block.one has invested in a total of 24 companies.[43]

124. In addition to funding development activities, Block.one appears to remain heavily involved in core protocol development for EOS. All the blog posts on the EOS website appear to be written by Block.one representatives. The top committer on the EOS repository works for a software consultancy who lists Block.one as a client, and many of the other committers appear to be located in Arlington, VA, which is one of Block.one's major offices. Notably, EOS does not have a formal merging policy for code submitted to the main repository, which is the process by which proposals for improvements to the core protocol are integrated, so I can only assume that Block.one employees maintain full powers relating to which requests to merge and which to reject.

125. Aside from core protocol development, it is not unusual for the original developer of a base layer protocol to subsequently join other third-party participants in developing additional applications on top of the protocol. For example, Block.one is developing an application called "Voice" on the EOS blockchain, which is a decentralized social media application.[44]

2. Stellar

126. Stellar is a blockchain and smart contract platform similar to TON. The Stellar Development Foundation ("SDF") issues grants in the form of Stellar tokens to encourage development. Grants can be awarded for general purpose projects designed to incentivize activity on Stellar, or for academic research that is in line with the SDF's goals.

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[42] See: https://vc.eos.io/funding/
[43] See: https://vc.eos.io/companies/
[44] See: https://block.one/news/block-one-introduces-social-media-application-voice/

127. The SDF controls a significant number of Stellar tokens, which they use to fund various initiatives. Specifically, using December 4, 2019 prices, the fund has nearly $655 million in an operating budget designated for hiring engineers and general development. $109 million is budgeted for ecosystem support, with half allocated to infrastructural grants and the remaining half to be used to provide currency support by creating token tethers and ensuring token liquidity. $546 million is dedicated towards connecting Stellar to various use cases, such as Stellar wallets. 20% of this is to be given away in the form of grants, and the remaining 80% of the use case funds are to be used to invest in or acquire business. The remaining $327 million is split between marketing and airdrops of Stellar designed to encourage usage. The SDF is a 501(c)(3) nonprofit registered in Delaware, so any investments gains roll back into the general fund.

128. The SDF appears to be the primary actor in terms of engineering, marketing, and outreach. Decisions on changes to core functionality must be unanimously approved by a core team, composed entirely of SDF employees. Changes to non-core functionality is less restrictive in that unanimity is not required, but in some cases, approvals require approvals directly from at least two SDF employees.

3. Ethereum

129. The history, foundation, and planned development of Ethereum is examined in detail in Appendix C and summarized here. The foundation sees its role in the ecosystem as serving three functions:

a. Resource allocation. The foundation holds 0.6% of all ether (approximately $90 million as of December 2019) and applies those funds towards development of the platform.

b. Leadership. The Ethereum Foundation can guide development, encourage community growth, and highlight projects that are important to Ethereum's core processing.

c. Representation. The foundation serves as a way to begin working with Ethereum for those who may be interested in the platform and serves as a single representative in a way that a mass of developers would not ordinarily be able to.

130. The foundation's stated goals are to essentially remove themselves from the equation by fostering community growth until Ethereum can stand alone. In this sense it is similar to the stated goals of TON.[45]

131. The foundation provides an "ecosystem support program", which helps grant recipients refine their budgets, and connects them to other applicants to ensure more successful deployment of grant funding.

132. The Ethereum Foundation plans to spend $30 million between 2019-2020 on projects, including technical improvements, supporting core features, improving developer education, community gatherings, and website development. In terms of legal structure, the Ethereum Foundation is a Swiss non-profit called Stiftung Ethereum.

133. At present, Ethereum is working on a transition to PoS consensus algorithm, similar to the design of the TON blockchain, which is referred to as "ETH 2.0." I understand there are ten teams working on the development of Ethereum 2.0. Out of the ten teams, eight are being funded by the Ethereum Foundation and/or related parties, such as Ethereum founder Vitalik Buterin. Furthermore, from a total of $9.5 million in disclosed funding, $9.0 million is being provided by the Ethereum Foundation and/or related parties.[46]

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[45] 2018 Stage A Primer (TG-003-00000056), p. 20.

[46] See: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/eth2.0-teams/teams-building-eth2.0/

134. The evidence on comparable blockchains indicates that it is not uncommon for issuers and ecosystem foundations to remain involved in core protocol development and funding for external developers. However, the development community for open source public blockchains is often much larger than any single organization. As of June 2019, Electric Capital reports 6,842 active open source blockchain developers, with over 1,200 on Ethereum alone.[47] In summary, the open source nature of the TON blockchain protocol, as well as the ability of third-party developers to produce competitive applications and services, suggests that Telegram is one of many participants in the system, as opposed to an essential manager.

IX. ECONOMIC USES FOR GRAMS

135. Cryptocurrency users are typically motivated by one of two reasons, which may not be mutually exclusive. The first is profit, typically through price appreciation, and the second is consumptive utility value, which can take many forms. Determinants of price appreciation are examined in Section XI, while this section analyzes consumptive uses for Grams.

136. Consumptive uses fall into two categories: goods and services provisioned within the network, and those that are external to the network. I begin with an analysis of internal economic uses of Grams as the TON's native cryptoasset.

137. As of the time of the launch of TON platform, it is anticipated that Grams will immediately be useable within the platform for:

a. Paying for the processing of smart contracts and applications that are developed on the TON Blockchain by third parties as part of TON Services;

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[47] See: https://www.electriccapital.com/developer_report_H1_2019_pdf

b. Paying for services or the storing of data through TON Storage, which is expected will be available at the time of the anticipated launch of the TON Blockchain;

c. Paying for service for assigning human readable names to accounts, smart contracts, services and network nodes as part of TON DNS;

d. Paying for TON Proxy – a network proxy/anonymizer used to safeguard the identity and IP addresses of TON nodes; and

e. Payments to the masterchain in order to publish a new workchain.

138. Notably, based on the documents and communication which I have reviewed, the work on TON DNS, TON Payments and TON Services has already been completed, whereas the development of TON Storage and TON Proxy is nearing completion.[48]

139. Based on my review and analyses of the economic uses of Grams available to the TON blockchain users when the ecosystem becomes fully functional, Grams are designed to perform as a currency that can be used to buy goods and services on the TON Blockchain. With respect to this defining intended purpose, Grams will be similar to the native asset on other smart contract protocols like Ethereum and EOS, which share similar characteristics with Grams across the various components of the functionality stack. The demand-side consumptive uses of Grams by TON Blockchain users are discussed in more detail below.

A. TON Payments

140. TON Payments is a service designed to facilitate transferring Grams quickly and efficiently between users. Similar to Bitcoin's "Lightning Network", it is intended to offer near instant value transfers between users, bots and other services, at near zero transaction cost. These

[48] Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, Nos. 2 and 5, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019).

types of transactions are simply infeasible with fiat currency. Such payments may be used to pay for small transaction fees associated, for example, with using a TON file-storing service or other services/dApps deployed on the TON blockchain.

141. What distinguishes TON Payments from other centralized built-in payment services affiliated with existing for-profit messenger applications (for example, Messenger Pay and WhatsApp Pay owned by Facebook, or WeChat Pay owned by Tencent Holdings) is its truly decentralized nature. First, TON payment channels are built upon a decentralized, censorship-resistant blockchain, so that no central authority can stop, seize, or refuse payments. Second, monetization of users is not a commercially-driven objective, therefore, control over payment fees resides with peer-to-peer liquidity providers which should create a free and competitive market.

B. TON Storage

142. TON Storage is a decentralized cloud-storage service designed for users to store data. The module also serves as a data store technology for the TON Blockchain ledger so that validating nodes don't need to store the entire history, which can become substantial as a blockchain ledger grows. In its simplest form, it allows users to store files on a distributed network of hardware and pay for these storage services in Grams.

143. TON Storage is therefore based on a decentralized approach to creating a market, where anybody possessing the required disk space would offer their services to those needing them. For example, there might exist a "market" or an "exchange" where all nodes interested in keeping files of other users publish their contact information, along with their available storage capacity, availability policy, and prices. Those needing these storage services choose and agree on prices with storage providers, create smart contracts in the blockchain and upload files for off-

chain storage. As the result, TON Storage is designed to be truly decentralized to the extent that it would not need to rely on any centralized cluster of servers for storing files.[49]

C. TON DNS

144. TON DNS is a predefined service that provides ability to assign human-readable names to accounts, smart contracts and network nodes.[50] This service allows users to access decentralized services as easily as browsing the World Wide Web. TON DNS will also allow all the TON users to quickly find each other, increasing the security and overall privacy.

145. TON DNS is an innovative part of the service stack offered by the TON blockchain because many blockchain services, such as decentralized file storage, will reside largely off-chain. In such instances, TON blockchain will be able to locate the abstract address or addresses of the service through TON DNS which facilitates the translation of abstract addresses into domain-like human-readable strings, and vice versa. Furthermore, TON DNS improves the ease of transactions between the blockchain users. For example, a user looking to transfer certain amount of cryptocurrency to another user or to a merchant may prefer to remember a TON DNS domain name of the account of that user or merchant, instead of keeping their 256-bit account identifiers at hand and copy-pasting them into the recipient field in their wallet application.[51]

146. Users wishing to register blockchain-based human-readable domain names, will pay for such service with Grams. For example, in order to register a new subdomain of an existing domain, a user would simply send a message to the smart contract, which is the registrar of that domain, containing the subdomain (i.e., the key) to be registered, the value in one of several

[49] TON White Paper, p. 103.
[50] *Id.*, p. 105.
[51] *Id.*, p. 105.

predefined formats, an identity of the owner, an expiration date, and some amount of Grams as determined by the domain's owner.

D. TON Proxy

147. TON Proxy is a network proxy service (so-called anonymizer layer) which can be used to create decentralized virtual private network services and blockchain-based alternatives to achieve anonymity of communications and protect online privacy. It may be used to by individuals to protect their private financial information, as is common in many financial markets. Additionally, it may also be used to increase security via resistance to denial of service attacks by disguising IP addresses and geographical locations of TON validator nodes.[52]

E. TON Services (dApps)

148. The architecture of TON blockchain naturally lends itself to the development of multiple decentralized applications powered by smart contracts and enhancing user experiences ranging from decentralized file storage to executing complex computations to gaming. The economic value of such dApps-driven user transactions and their impact on a native cryptoasset adoption and its intrinsic value cannot be overstated.[53]

149. Application and services developers are those that create tools and applications on top of a blockchain such as TON. Their collective efforts impact usage of the cryptoasset and, as discussed in Section XI, network activity is one of the primary drivers of value creation for cryptoassets.

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[52] TON White Paper, p.3.

[53] Recent study by Yermack et al (2019) finds that so-called ERC20 tokens issued on the Ethereum platform for usage with specific decentralized applications have higher chance of success than other types of ICOs because they provide economic utility to blockchain users.

150. According to the data from the State of the dApps website, tracking decentralized applications across major public blockchains, there are currently over 3,200 dApps in existence, with about 60 new dApps being deployed each month.[54] On the Ethereum blockchain alone, over 2,000,000 dApps-related transactions occur every month, with nearly 63,000 transactions taking place every day involving nearly 21,000 active users. On EOS blockchain, hosting more than 300 dApps at the present moment, daily dApps-related transaction count exceeds 450,000, with nearly 14,000 active daily users involved. Across all dApps-enabled public blockchains, there are more than 14,000 active smart contracts, with over 125,000 active daily users and over 41,000,000 daily transactions.[55]

151. With respect to facilitating decentralized applications within a blockchain ecosystem, TON blockchain is similar to Ethereum and EOS blockchains. Similar to the Ethereum Virtual Machine and EOS Virtual Machine, the ability of TON to function as a decentralized supercomputer is driven by the TVM. TVM is the computation layer for smart contracts and dApps, and it is used to execute smart contract logic.

152. TON decentralized applications executed by TVM reside entirely on the TON blockchain and represent one smart contract or a collection of smart contracts. To execute the decentralized application, the developer would effectively rent the computing power from the validator nodes, and will pay for it in Grams directly or have dApp users pay for it. The interaction between dApps users or smart contracts is performed via TON blockchain messages sent to or received from these contracts.

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[54] See: https://www.stateofthedapps.com/stats#new
[55] See: https://www.dapp.com/ranking

153. Based on the documents which I have reviewed, the run time environment for executing decentralized applications is anticipated to be fully functional at the time of the launch of the TON mainnet and Gram cryptoasset.

F. Consumptive Uses of Grams External to TON

154. Ever since bitcoin was famously used to purchase a pizza on May 22, 2010,[56] it and other major cryptocurrencies have become increasingly accepted as method of payment to acquire goods and services. Among hundreds of examples, Microsoft accepts bitcoin directly for software and cloud services, Expedia and Cheapair accept bitcoin to purchase travel, Overstock accepts major cryptocurrencies for household products, and AT&T accepts major cryptocurrencies for its services. Companies such as BitPay[57] and Flexa[58] have integrated payment systems with hundreds of merchants so that customers can pay for items with cryptocurrencies. Multiple law firms, including Quinn Emanuel Urquhart & Sullivan, now accept bitcoin and other cryptocurrencies.[59] If you owe taxes to the state of Ohio, you can pay them with bitcoin.[60] Once Grams become live, it is my opinion that many of these entities are likely to accept Grams for goods and services.

155. Digital wallets are a key application to facilitate payments to external parties and are often developed and deployed by independent, third party developers. In this respect, significant development activity is currently occurring on these user interfaces for TON.

156. The TON wallet is the official wallet for the TON Blockchain's native Grams. Through an automated bot, users can request free test Grams to use with their TON wallet. It was

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[56] See: https://qz.com/1285209/bitcoin-pizza-day-2018-eight-years-ago-someone-bought-two-pizzas-with-bitcoins-now-worth-82-million/
[57] See: https://bitpay.com/directory/
[58] See: https://flexa.network/
[59] See: https://www.law.com/americanlawyer/2019/11/05/quinn-emanuel-says-clients-can-pay-in-bitcoin/
[60] See: https://fortune.com/2019/01/03/ohio-bitcoin-overstock/

recently released for users to participate in the platform's Testnet and become accustomed with the application's functionality.[61] According to Telegram, the TON Wallet is non-custodial in nature, meaning that Telegram will have no greater insight or access to transactions on the TON Blockchain than any other user of the TON Blockchain.[62] The test version of the TON Wallet was released on November 1, 2019, and once users download a version of the wallet from Telegram's official website, they are able to receive and send Grams on the TON testnet.[63] As of November 2019, tens of thousands of parties have downloaded the TON Light Client and TON Light Wallet from the site.[64]

157. Based on my review of available information, TON Wallet will not be an exclusive decentralized application available to store and transfer Grams. Specifically, third parties have also developed digital wallets to store and transfer Grams.[65]

158. The Atomic wallet is a third-party interface that allows users to purchase cryptoassets with fiat currency or enter swaps for various other cryptoassets. The wallet has an extensive list of assets totaling over 300, which a user can acquire. The wallet will be usable for Grams once the TON Blockchain is launched.[66]

159. Mercuryo is a third-party wallet and exchange, which allows users to purchase cryptoassets using their bank card. It also allows businesses to accept payments in crypto, which can subsequently be converted to Euros through the Mercuyo wallet's interface. Currently, users can purchase the following tokens using Mercuryo: Bitcoin, Ethereum, Basic Attention Token,

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[61] See: https://cointelegraph.com/news/telegrams-grams-wallet-is-available-on-github-in-test-mode
[62] Defendants' Answer, Defenses and Affirmative Defenses to Plaintiff's Complaint, ¶ 115, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 12, 2019).
[63] See: https://www.coindesk.com/telegram-releases-test-crypto-wallet-despite-sec-lawsuit
[64] Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, No. 5, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019).
[65] See: https://buttonwallet.com/; https://mercuryo.io/business/acquiring/; https://atomicwallet.io/ton-wallet
[66] See: https://atomicwallet.io/ton-wallet

Tether, and Algorand,[67] and Mercuryo has stated it will process payments in Grams once TON launches the mainnet.[68]

160. The Button wallet is a third-party wallet integrated with Telegram Messenger through which users can buy and sell cryptocurrencies, exchange one cryptocurrency for another and send cryptocurrencies to other users. The wallet currently has 80,000 users from 118 countries around the world and supports multiple coins, including: Bitcoin, Ethereum, Litecoin, Bitcoin Cash, Ethereum Classic, Waves, Stellar Lumens and other ERC-20 tokens.[69] The Button wallet will facilitate exchange of Grams for other cryptocurrencies. At the moment, the Button Wallet's transaction service is hosted within the Telegram Messenger and operates via more than 800,000 Telegram Bots that enable a variety of transactions, including semi-automated payment processing, group management, game notifications, donations, etc.[70] The wallet is currently available for use on the TON Testnet,[71] so I expect it will also be available on the mainnet.

161. Parjar is a wallet application that is already integrated within Telegram messenger which is designed to transfer cryptoassets between users. Parjar currently supports transactions with over 40 cryptoassets[72] on Telegram's messenger and claims to have processed over half a million transactions from 21,000 people in the last year.[73] Given their current integration with Telegram, I expect Parjar to support Grams once TON's mainnet is launched.

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[67] See: https://mercuryo.io/
[68] See: https://mercuryo.io/business/acquiring/
[69] See: https://buttonwallet.com/
[70] Simos, Elias "The Current State of Telegram Open Network: A sleeping giant awakens." October 2019, p. 18-19. See: https://drive.google.com/file/d/1PCEypWk6Z4QLdyvhXm1CRk79pQ0Zkbkp/view
[71] See: https://www.forbes.com/sites/billybambrough/2019/08/26/telegrams-300-million-users-could-soon-be-trading-bitcoin-and-cryptodespite-serious-security-warning/#16eb1ee43fe9
[72] See: https://www.parjar.io/coins
[73] See: https://beincrypto.com/cryptocurrency-tips-on-telegram-reach-500000-milestone-in-just-a-year/

162. Spatium is a wallet application under development with a focus on enterprise-level security using biometrics and storage of over 150 cryptoassets. Spatium has announced it intends to support Grams at TON mainnet launch.[74]

163. In addition to wallet applications, other third-party developers are creating dApps for use on the TON blockchain. For example, two different third parties have created dApps for buying and selling good—one uses auctions[75] while the other creates a market for buyers and sellers to interact directly.[76] Another third party has developed a dApp to store and track school grades with the stated intention of eliminating the possibility of the grades being falsified.[77]

164. Another example of a third-party developer who is focused on integrating with multiple facets of the TON platform is Viewst, which makes software for creating online ads, with a focus on interactive video in social media. Its website touts its expected integration once TON's mainnet launches with TON's platform in multiple ways. For example, Viewst expects to accept Grams via TON Payments, with a focus on micropayments, and it expects to utilize TON Storage for optimizing storage of large video files.[78]

165. Independent developer teams, such as the ones described above, and others listed in Exhibit 4, are expected to play a central role in on-boarding users of Grams. Through their service offerings and products, they are contributing to the platform's widespread adoption. The long-term adoption and success of TON will rely significantly on the decentralized efforts of such developer teams.

[74] See: https://dcntrlzd.app/2019/10/05/spatium/
[75] See: https://github.com/deNULL/ton-auction
[76] See: https://github.com/ftkvyn/ton-goods
[77] See: https://github.com/ftkvyn/ton-register
[78] See: https://viewst.com/

G. Grams are Comparable to Other Medium-of-Exchange Cryptocurrencies Based on Its Functional Economic Uses

166. In its focus on using Grams as native cryptocurrency as means of payment for digital goods and services, TON blockchain is similar to several other protocols built around consumer friendly dApps or user ability to rent distributed computing or storage resources.

167. Ethereum blockchain went from zero dApps to over 2,700 dApps between April 2015 and the present moment, with quarter-million of active monthly users and nearly 4,000 smart contracts deployed.[79] Ethereum dApps widely range in nature, from decentralized finance (lending/borrowing Ether and other tokens, crypto-to-crypto trading) to games to collectibles and lotteries.[80] Notably, similar to TON DNS service, Ethereum hosts a dApps called Ethereum Name Service ("ENS") which converts an alphanumeric Ethereum user address to a human readable format.[81] In addition, similar to Grams' usage to pay for transaction fees and the deployment of smart contracts, Ether token is used to pay for the number of computations required to be performed in order to execute a transaction or a smart contract in the form of so-called gas payments.[82]

168. On EOSIO, the number of dApps rose from zero in September 2017 to over 300 presently, with nearly 500 smart contracts in existence.[83] Aside from using EOS token inside dApps, the top categories of which include games, gambling, social, finance/exchanges, and storage, EOS token users, including application developers, can also use the tokens to buy extra memory bandwidth from other token holders through what is called RAM marketplace, as well as unutilized computational resources (CPU power) and storage space. Those users who act as block

[79] See: https://www.stateofthedapps.com/stats/platform/ethereum#new
[80] See: https://docs.ethhub.io/using-ethereum/ethereum-new-user-guide/
[81] See: https://app.ens.domains/
[82] See: https://docs.ethhub.io/ethereum-basics/development/testing/#gas
[83] See: https://www.stateofthedapps.com/stats/platform/eos#new

producers on a given shardchain, can also buy extra unutilized memory bandwidth from that shardchain. Similar to EOSIO, upon the mainnet launch Gram users will be able to use Grams for dApps, as well pay in Grams for distributed storage services.

169. As far as the use of the TON Storage service is concerned, it is similar to Sia decentralized storage blockchain and its native cryptoasset Siacoin. In particular, Sia enables the formation of cryptographic storage contracts between peers. Contracts are agreements between a storage provider and their client, defining what data will be stored and at what price. They require the storage provider to prove, at regular intervals, that they are still storing their client's data. In return, file storage providers get paid in Sia coins by their clients.[84], [85]

X. TON BLOCKCHAIN IS DESIGNED TO BE A TRUSTLESS DECENTRALIZED BLOCKCHAIN WITH NO CENTRAL AUTHORITY, MANAGED BY A DECENTRALIZED SET OF VALIDATING NODES

170. Decentralization is a core concept in blockchains and distributed ledgers. Of primary concern is the distribution of resources dedicated to validation, because validators govern the operation of the network. Decentralization is a core component of the value proposition of blockchains because trust in the ledger is paramount. Lack of decentralization erodes trust because is means that the ledger is more susceptible to manipulation.

171. As described in Section VII, the two most common categories of consensus algorithms are PoW and PoS. I first review the degree of decentralization in Bitcoin and Ethereum, which both use PoW, and then turn to EOS and TON, which use PoS.

[84] Vorick, David and Luke Champine. "Sia: Simple Decentralized Storage." November 29, 2019. p.1. See: https://sia.tech/sia.pdf

[85] At the moment, Sia blockchain offers 2PB of decentralized storage capacity, provided by 333 storage providers, of which 709 TB of storage are used. See: https://sia.tech/

A. Decentralization of Mining in Bitcoin and Ethereum

172. Bitcoin and Ethereum are considered to be two of the most decentralized blockchains. However, while this may be true with respect to distribution of assets, decentralization of the primary function of the network, block production, has been called into question by scholars. Eyal and Sirer (2018) state (p. 95):

> "*Empirical evidence shows that Bitcoin miners behave strategically and form pools. Specifically, because rewards are distributed at infrequent, random intervals, miners form mining pools in order to decrease the variance of their income rate. Within such pools, all members contribute to the solution of each cryptopuzzle, and share the rewards proportionally to their contributions.*"

173. Mining pools reduce decentralization within PoW systems. One of the most well cited study of decentralization in the Bitcoin and Ethereum networks is Genser et al. (2018). They measure mining power based on block production over a 10-month period beginning July 15, 2016. They find that mining power in both networks is relatively centralized. Specifically, over their sample period they report that the top four miners in Bitcoin have 53% of the average mining power and the top three miners in Ethereum have 61% of the average mining power. Concentrations above 51% are of particular concern in PoW blockchains because this is the threshold required to monopolize control of the network and alter the ledger. The threat is not just theoretical, a 51% attack was observed in January 2019 on the Ethereum Classic blockchain.[86]

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[86] See: https://cointelegraph.com/news/coinbase-ethereum-classic-double-spending-involved-more-than-11-million-in-crypto

174. One counterargument holds that since the largest miners are typically pooled resources from many individual miners, the networks are in fact more decentralized than indicated by this analysis. However, Genser et al. (2018) address this concern directly:

"The argument that mining pools provide a degree of decentralization due to mining pool participants having a check on pool operator behavior has no empirical support. For instance, censorship attacks by pool operators are difficult, if not impossible, to detect by pool participants. Additionally, when miners exceeded the 51% threshold on three separate occasions in Bitcoin's history, the pool participants did not disband the pool despite clear evidence of a behavior widely understood to be unacceptable."

175. If anything, the authors argue that the networks may be more centralized than their analysis indicates:

"While strong miners gain political clout and attract more members, getting too large raises alarms among the community about centralization. Thus, such miners may conceal or obfuscate this information to appear less powerful – e.g. by generating multiple identities. For instance, two major mining pools, Ethpool and Ethermine, publicly reveal that they share the same admin. Thus, any analysis based on the voluntary miner data skews toward a more decentralized network than the reality."

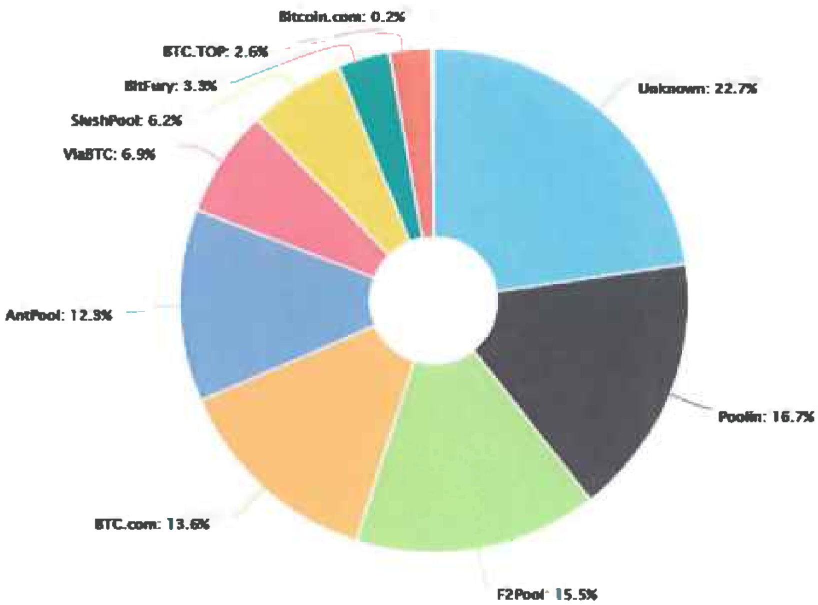
176. In summary, they state:

"Over 50% of the mining power has exclusively been shared by eight miners in Bitcoin and five miners in Ethereum throughout the observed period. Even 90% of the mining power seems to be controlled by only 16 miners in Bitcoin and only 11 miners in Ethereum. Hence, both platforms rely heavily on very few distinct mining entities to maintain the

blockchain. ... These results show that a Byzantine quorum system of size 20 could achieve better decentralization than proof-of-work mining at a much lower resource cost."

177. As this study was conducted more than two years ago, I report data on Bitcoin mining over a four-day period and Ethereum mining over a seven-day period ending December 1, 2019:

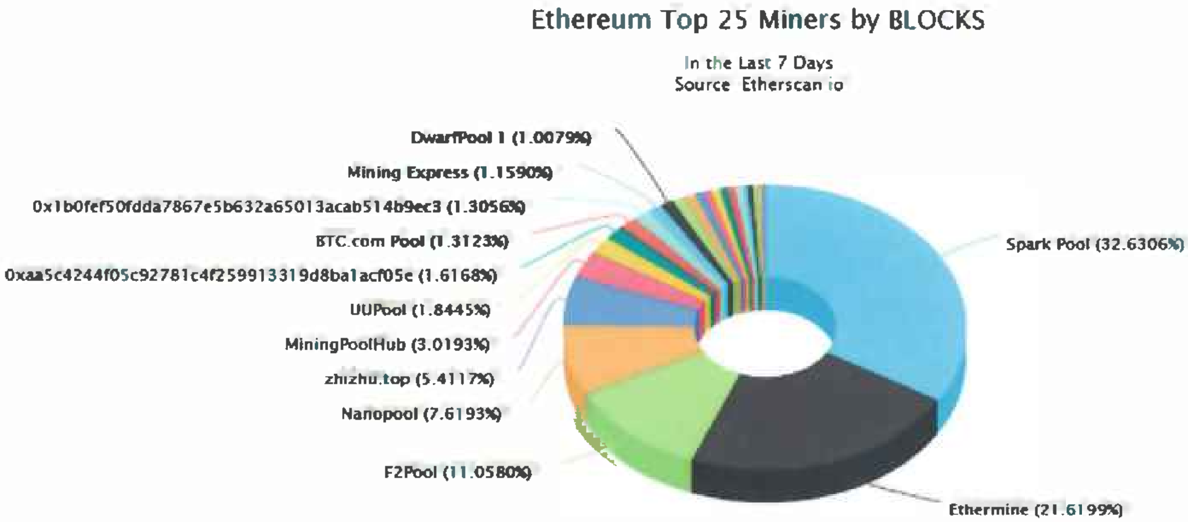
Figure 6: Mining distribution in the Bitcoin network[87]



178. As reported in Figure 6, the top four Bitcoin miners account for over 58% of the block production over this interval.

[87] See: https://www.blockchain.com/en/pools?timespan=4days

Figure 7: Mining distribution in the Ethereum network



179. As reported in Figure 7, the top three Ethereum miners account for over 65% of the block production over this interval.

180. Taken together, the recent figures indicate that the distribution of current mining power in the Bitcoin and Ethereum networks remains consistent with the findings of Genser et al. (2018).

B. Decentralization in EOSIO, a Competing PoS Blockchain

181. As described below, the TON platform is designed to be more decentralized than EOSIO, a blockchain platform currently in operation. In fact, the CTO of Block.One (the principal developer of EOSIO), Dan Larimer, has publicly stated that "decentralization isn't what we're after, what we are after is anti-censorship and robustness against being shut down".[88]

182. In comparing the validation protocols of TON and EOSIO, certain differences can be identified, which are informative as to the degree of decentralization of the two platforms.

[88] See: https://cointelegraph.com/news/blockone-joins-eos-elections-as-one-entity-allegedly-has-37-control

TON's White Paper describes its expected validation pools as follows: "Originally, the total number of validators is T = 100; we expect it to grow to 1000 as the load increases".[89] Furthermore, in Exhibit 2, I have identified 98 purchasers that are potential validators at the launch of the TON platform, based on the number of purchasers that are not subject to lockup and have purchased at least the stated 100,001 minimum number of Grams.[90] In the case of EOSIO, the platform's consensus mechanism, operating via a Delegated Proof of Stake ("DPoS"), allows for only 21 validators, known as EOS Block Producers.[91]

183. Furthermore, I understand that neither the TON Foundation (if it is established), Telegram, nor its employees can be validators and the Grams held by the TON Reserve and Incentive Pool cannot be staked in the validation process, nor can they participate in governance by voting on changes to the configurable parameters.[92] In contrast, on November 13, 2019, Block.One announced that it will be participating in elections to delegate EOS Block Producers, with up to 9.5% of network's circulating supply of tokens.[93] On the EOSIO platform, any user, who has staked EOS tokens can participate in the EOS Block Producer elections.[94] Shortly after, on November 28, 2019, an EOS Block Producer by the name of EOS New York, revealed that 6 out of the 21 validators on the network were managed by a single entity based in Shenzhen, China.[95] One of the problems that may arise from such centralization is the potential for collusion between the EOS Block Producers, who could trade votes to maintain their operations of their EOSIO nodes (Unlike EOSIO, TON is not designed to use delegated PoS, and therefore is not

[89] TON White Paper, p. 105, p. 47.
[90] See: https://test.ton.org/Validator-HOWTO.txt
[91] See: https://iang.org/papers/EOS_An_Introduction-BLACK-EDITION.pdf
[92] Telegram Group Inc. Fourth Supplemental Memorandum to the Staff of the SEC (July 25, 2019).
[93] See: https://block.one/news/blockone-to-begin-voting-for-eos-public-blockchain-upgrades/
[94] See: https://medium.com/@auroraeos/eos-voting-guide-3bf4e0be251b
[95] See: https://cointelegraph.com/news/blockone-joins-eos-elections-as-one-entity-allegedly-has-37-control

subject to potential collusion since there is no voting process). According to Cointelegraph, "Data from EOS Authority[96] gives weight to this claim [collusion], demonstrating that many top BPs share a vote confluence exceeding 80%".[97]

184. In September 2019, EOS Tribe, a company that helped the EOSIO platform get off the ground, announced that it was stepping down as an EOS Block Producer, citing collusion and vote exchanges by multiple other EOS Block Producers. According to the organization, "a vote buying and vote exchange practice went mainstream and wide-spread among BPs"[98] and "over time this leads to higher centralization of power and control to a smaller group of largest EOS holders who take all top 21 BP positions on chain".[99]

185. Similarly, more evidence of the centralization present on the EOSIO platform, comes from an analysis conducted on the top 10 EOS Block Producers categorized by Number of Voters Vs Total Vote Size. The analysis reveals a significant disparity between the two categories, with only 50% of top 10 EOS Block Producers belonging to both categories.[100] This points to the fact that many EOS Block Producers who receive the widest support from voters are being marginalized by EOS Block Producers receiving the support of a few large token holders, thus mitigating the effect of the votes cast by the broader EOSIO community and leading to more centralization.

186. Weiss Ratings, an investment research firm,[101] downgraded EOSIO on June 8, 2019 due to centralization concerns.[102] According to an article issued by the organization, "Too few

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[96] See: https://eosauthority.com/producers_relation
[97] See: https://cointelegraph.com/news/blockone-joins-eos-elections-as-one-entity-allegedly-has-37-control
[98] See: https://steemit.com/eos/@eostribe/my-reflection-on-eos-history-and-current-state
[99] *Id.*
[100] See: https://eosauthority.com/voting_analytics, as of December 20, 2019.
[101] Weiss Ratings provides ratings on stocks, ETFs, mutual funds, banks, credit unions, insurance companies and crypto assets.
[102] See: https://cointelegraph.com/news/weiss-crypto-ratings-downgrades-eos-due-to-centralization-concerns

people own too many tokens. They have an oversized influence on voting. And there are few formal incentives to encourage other token-holders to vote."[103] The article continues: "EOS is resigned to being a semi-centralized, distributed ledger."[104]

187. The issue of centralization in EOSIO, based on the outsized influence of participants with large amounts of EOS tokens, has long been a concern for EOSIO developers and the crypto community, with EOSIO doing little to alleviate such concerns. Moreover, EOSIO also suffers from geographic centralization. On June 10, 2019, Cryptoslate.com released information pertaining to the geographic location of EOS Block Producers, revealing that 48% were located in China and Hong Kong, with 67% being based in Asia.[105] This geographical concentration is further supported by a statement by Brock Pierce, a co-founder of Block.one, in June 2018 in which he said that "the ecosystem is a little bit of a Chinese oligarchy right now."[106]

C. TON Blockchain Consensus and Validation Process is Designed to Provide Decentralization

188. The TON governance system provides for several built-in mechanisms designed to achieve the decentralization of the block validation operations and the accrual of the resulting validation rewards. Specifically, such mechanisms are designed to (1) expand the validator set over time; (2) empower the broader user community to vote on changes to the parameters for choosing validators; (3) limit the size of a given Gram stake, no matter how large, to the maximum validating load a given node is willing to accept; and (4) enable individual blockchain users to pool their Gram resources in order to select (vote for) validators.

[103] See: https://weisscrypto.com/en/article/eos-problem-network-too-centralized
[104] *Id.*
[105] See: https://cryptoslate.com/eos-voting-structure-encourages-centralization/
[106] See: https://youtu.be/SdzF4X1Eb2c?t=60

189. First, to be valid under the BFT protocol, blocks must collect signatures of at least two-thirds of all the validators (by stake), and these signatures must be included in the new block for the block to be trusted. If too many signatures are to be included into each and every block, more data would have to be stored by all full nodes and propagated through the entire ledger, and more processing power would have to be spent to check these signatures. In this respect, TON blockchain actually sets more ambitious goals for itself in terms of the decentralization of the block validation process and, specifically, aims at increasing the initial set of validators from approximately 100 validators (for Testnet) to approximately 1,000 validators.[107] In this respect, TON blockchain is designed to be notably more decentralized than other existing PoS protocols: for example, comparable PoS blockchains EOS[108] and Steemit[109] rely only on 21 validators in their respective validator sets, whereas other PoS blockchains such as TRON,[110] Stellar,[111] Ark,[112] Cosmos[113] and Lisk,[114] all have between 27 and 101 validators in their validation protocols. Delegated Proof of Stake algorithms, such as EOS, have further threats to decentralization due to voting cartels. In addition, TON validation protocol is designed to be visibly more decentralized than existing major PoW cryptoassets, discussed above, which is widely decentralized in theory with respect to block production, but in reality all suffer from an increasing concentration of mining hash power in the hands of a few large pools.

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[107] TON White Paper, p. 47.
[108] See: https://whitepaperdatabase.com/eos-whitepaper/
[109] See: https://steem.com/faq/
[110] See:
https://github.com/tronprotocol/documentation/blob/master/English_Documentation/TRON_Blockchain_Explorer/What_is_a_Super_Representative.md
[111] See: https://stellarbeat.io/
[112] See: https://ark.io/
[113] See: https://cosmos.network/docs/cosmos-hub/validators/overview.html
[114] See: https://lisk.io/blog/research/introducing-byzantine-fault-tolerance-consensus-lisk

190. Second, TON documents specify several configurable parameters which may be changed to alter (1) the minimum coin stake for validators; (2) the maximum size of the group of elected validators; (3) the maximum number of blocks of transactions for which the same group of validators are responsible; (4) the validator election process; (5) the validator punishing process; (6) the currently active and the next elected set of validators; and (7) the process of changing configurable parameters themselves.[115]

191. According to the TON documents which I have reviewed, any validator may suggest a new value for most of the above configurable parameters to other validators. If the suggested value is valid, further voting messages from the validators are collected by the smart contract, and if more than two-thirds each of the current and next sets of validators support the proposal, the value is changed. If the validator election procedure needs to be changed, this can be accomplished by changing the ordinary configurable parameter containing the address of the validator election smart contract and then by obtaining the approval by two-thirds of the validators to accept the proposal in a vote. In essence, most fundamental parameters and smart contracts of the TON Blockchain may be modified in any direction agreed upon by the qualified majority of the validators.[116]

192. Third, to become a validator, a TON blockchain node must not only transfer Grams and lock them on the masterchain, but it must also define another parameter that represents the maximum validating load that they are willing to accept.[117] This load parameter is capped, ensuring that validation loads are more equitably spread across validators regardless of the sizes of their stakes.

[115] Telegram Open Network Blockchain, October 3, 2019, p. 24-25. See also: TON White Paper, p. 47.
[116] Telegram Open Network Blockchain, October 3, 2019, p. 26.
[117] TON White Paper, p. 47-48.

193. In summary, to the extent that (i) the validator set expands over time, (ii) parameters for choosing validators set may be changed through voting, (iii) the weight of a given Gram stake is limited to the actual validating work a node is willing to perform, and (iv) the ability of individual blockchain users to pool their Gram holdings together to nominate validators or become validators themselves, the decentralization-driven mechanisms described above effectively ensure every willing user's ability to participate in or propose and vote on changes to the blockchain protocol governing the election and activities of TON validators. These features, coupled with the evidence on centralization of block production within Bitcoin, Ethereum, and EOSIO, indicate that TON is designed to be more decentralized than these existing alternatives.

XI. DETERMINANTS OF VALUE FOR CRYPTOCURRENCIES AND UTILITY TOKENS

A. How are Returns Generated?

194. Native assets of decentralized public blockchain protocols do not map directly to any traditional asset classes. They may contain uses related to capital markets, product markets, and/or labor markets. Thus, traditional valuation methodologies such as discounted cash flow analysis that are used to value cash flow generating assets, such as stocks or bonds, are often inappropriate or incomplete. In this section I review current approaches to valuing cryptoassets and related literature on determinants of returns.

195. Most securities and investment contracts can be valued as a function of cash flows. The price of a share of stock in a corporation is a function of investor expectations regarding the level and riskiness of future free cash flows available to equity holders, which may be paid out via dividends or upon liquidation of the assets. The price of a debt security such as a corporate or municipal bond is similarly a function of future cash flows, which may be paid out as coupon or interest payments, and/or a face value paid at maturity. These cash flows are typically earned

passively, meaning that the investor need not do anything more than hold the security. Cash flow generating assets such as stocks and bonds can be valued using discounted cash flow analysis, whereby expectations of future cash flows are discounted by a required rate of return, which is a function of the riskiness of the cash flows.

196. It is important to understand that blockchain protocols such as TON are not businesses and the assets of the protocol are not inherently cash flow generating. Rather, financial returns are generated in one of two ways: contribution of work to the network, and/or price appreciation of the asset.

B. Contribution of Work

197. Contribution of work to a network can take a variety of forms. An illustrative example is that of validators. As discussed above, validators perform the critical work of posting transactions to the ledger. To do so, they must possess sufficiently a large stake, either directly or by proxy, and invest in (or contract for) hardware capable of performing the required computations. Validators in the TON network are rewarded with additional units of Grams in exchange for this contribution of work. Similarly, those that perform the collating, nominating, or fishing functions are rewarded with additional units of grams for this work.

198. Importantly, holders of Grams that do not participate in the validation function do not earn any rewards or profit via this mechanism. In other words, they do not generate profits related to validation by passively holding Grams. In this sense, Grams act like a taxi medallion or "work token." They permit the holder to perform work that can generate returns, but do not generate income if no work is performed, similar to the way the owner of a taxi medallion would not generate income if no one uses it to drive a taxi. They either need to perform the work or contract with a third party to perform the work.

C. Literature on Price Appreciation and Sources of Value Creation

199. Outside of contribution of work, an alternative mechanism to generate profits by holding Grams is through price appreciation. Several academic studies have examined token valuation both theoretically and empirically. I briefly review related literature below.

200. Cong, Li, and Wang (2019) develop a theoretical model of token valuation and find that network effects and platform productivity are significant determinants of token prices. Cong, Li, and Wang (2019) model the prices of tokens as a function of (i) Users' desire to participate in the system (network effects) and (ii) Functionality improvement over time. In related work, Pagnotta and Buraschi (2018) also find that platform productivity and network effects are significant determinants of fundamental value.

201. The theoretical model in Cong, Li, and Wang (2019) allows for users to decide whether to incur some participation cost for joining a network, and how many tokens to hold throughout time. Holding tokens allows the users to engage with the network by using services built onto the network.

202. At very high levels of user participation, network effects have low marginal impact on prices. In other words, once the network reaches substantial scale, large changes in the user base have relatively small impacts on expected prices. At scale, prices are much more a function of network efficiency.

203. During the pre-launch phase of network development, although third-party development has been significant, Telegram has been a primary contributor to productivity growth. However, once the network is launched, all network participants are incentivized to contribute to future growth as the network transitions to a public good in which economic surplus is shared. For example, a firm that wishes to operate their own messaging service on TON would invest their

own development time into improving the network. Telegram cannot shut this competitor down by manipulating the chain, and the competitor could profit from the network through the economic value communicated through the chain. Both firms can contribute to a shared public good (TON) and both would benefit from doing so. Similarly, Telegram can develop a wallet and integrate it into Messenger, which increases both network effects and network functionality, but so too can an independent developer and there is evidence that competitive services are already being developed as described earlier.

204. Biais et al. (2018) examine equilibrium cryptocurrency pricing and find that the fundamental value of a token is the stream of net transactional benefits it provides. Transaction benefits, capture a benefit that a token allows but a fiat currency does not. Benefits might include the ability of a user to transact using a more stable currency than the fiat currency in times of national banking stresses, or the ability to purchase a service more cheaply on a decentralized network that is either less efficient or unavailable in the fiat economy.

205. Biais et al. (2018) estimate the determinants of Bitcoin returns and find that expected returns are higher when transaction costs are higher, but they are negatively related to transaction benefits. This is similar to the argument of Cong, Li, and Wang (2019), where greater usefulness leads to greater returns.

D. Valuation Methodologies

206. Appendix B reviews a variety of valuation methodologies for cryptocurrencies and utility tokens in detail. While widely accepted valuation methods remain elusive given the relatively nascent stage of cryptoassets, it is reassuring that the methodologies are grounded in the same economic principles as the theoretical literature reviewed in the previous section. More specifically, appreciation in the price of cryptocurrencies and utility tokens is directly related to

demand by a decentralized user base, which is driven by functionality and transactional benefits. In the case of Grams, it is useful to note that the proportion of the network that is associated with validation staking is capped at 10%, thereby leaving the vast majority of the assets available for transactions.

207. Various methods of assessing network activity have been proposed. One option is to measure transaction volume that occurs on-chain, which is more likely to be associated with consumptive uses relative to transactions on exchanges. Another metric uses the number of active addresses, in an attempt to assess the degree of decentralization in the userbase. Finally, some analysts use the equation of exchange, whereby the total value of goods or services procured by the network is estimated, as is the rate of turnover.

208. From the analysis of methodologies in Appendix B as well as the academic literature described above, I conclude that utility of cryptoassets spurs network effects and increased adoption, which are determinants of value. In contrast, emphasizing investment potential may deter use of coins (Howell, Niessner, Yermack, 2019). Thus, a sponsor interested in achieving a successful platform should be motivated to emphasize utility of the cryptoassets. Further, Zimmerman (2019) models the interaction between monetary users and speculative purchasers in the market for cryptocurrency. He finds that speculators can crowd out consumptive users on networks that are congested due to low throughput, and that the speculators therefore have a negative impact on prices. Because TON is designed to be highly scalable, it is more conducive to consumptive uses rather than investment speculation in comparison to PoW protocols like Bitcoin and Ethereum.

E. Systematic Component of Returns

209. While the methodologies above address the idiosyncratic, or network-specific, component of returns, it is also important to note the systematic, or market-wide, component. Cryptoasset returns are highly correlated. I examine daily return correlations using data from Coin Metrics for the six of the ten largest cryptoasset networks over an 18-month period from July 2018 to December 2019.[118] I choose 18 months as the evaluation period because EOS, one of the closest comparable projects to TON, launched just over 18 months ago. Table 1 reports that correlations are above 0.631 for all asset pairs and as high as 0.852 for EOS and ETH, the two largest smart contract platforms that are the closest comparable networks to TON.

210. What this indicates is that systematic shocks to the entire market, which impact all assets, account for the lion's share of returns. Any profits related to price appreciation from systematic returns are not attributable to the efforts of any particular party, but rather to the market forces broadly defined.

Table 1: Correlation matrix of returns to leading cryptoassets

	BTC	ETH	XRP	XLM	LTC	EOS
BTC	1.000					
ETH	0.816	1.000				
XRP	0.631	0.766	1.000			
XLM	0.653	0.731	0.743	1.000		
LTC	0.780	0.841	0.697	0.707	1.000	
EOS	0.757	0.852	0.739	0.716	0.843	1.000

211. The high degree of correlation is illustrated visually in Figure 8, a chart of prices for ETH and EOS, normalized to 1 as of July 1, 2018. As of this writing, these are the two largest smart contract platforms.

[118] BTC forks and stablecoins are excluded.

Figure 8: Time series of prices for ETH and EOS over July 2018 to Dec 2019

Table 2: R^2 values from market model regressions

	R^2	
Index:	BITW100	Equal-weighted
BTC	0.648	0.729
ETH	0.530	0.874
LTC	0.483	0.831
EOS	0.465	0.852
XLM	0.346	0.733
XRP	0.337	0.740

212. Finally, Table 2 reports R-squared values from market model regressions for the same cryptoassets analyzed in Table 1. R-squared, also called the coefficient of determination, is the proportion of the variance in the dependent variable that is explained by the independent

variables. In the specification I consider, the R-squared values can be interpreted as the percentage of the returns to the asset that are explained by returns to the aggregate market.

213. The daily returns for each cryptoasset are regressed on a measure of aggregate returns to the cryptoasset market, and a constant as in the following specification:

$$Returns_{i,t} = \alpha + \beta\left(Returns_{market,t}\right) + \epsilon$$

214. Where i is a specific cryptocurrency or utility token from the list in Table 1, and the market proxy is either the Bitwise 100, a value weighted index of the top 100 cryptoassets, or an equal weighted index comprised of the six assets that appear as dependent variables.[119] These six assets account for over 92% of the market capitalization in the Bitwise 100 index.

215. Because Bitcoin dominates the value weighted Bitwise 100 index, it is not surprising that is has the highest value at 0.648, meaning that the index returns explain 64.8% of the returns to Bitcoin. The R-squared values for the equal weighted index are even higher, for example, the equal weighted index returns explain 87.4% of the returns to holders of Ether over the sample period. Taken together, these results indicate that aggregate market forces explain a substantial portion of returns to cryptoassets similar to Grams.

XII. CONCLUSION: GRAMS ARE SIMILAR TO OTHER EXISTING CRYPTOASSETS THAT ARE NOT REGULATED AS SECURITIES

216. TON blockchain, and its native asset Grams, have key similarities to other existing blockchain protocols and commodity-like cryptocurrencies that have not been regulated as securities. These similarities have been discussed throughout this report and I summarize them here to conclude the report.

[119] See: https://www.bitwiseinvestments.com/indexes/Bitwise-100

217. In June 2018, William Hinman, the Director of the Division of Corporate Finance of the SEC, stated: "based on my understanding of the present state of Ether, the Ethereum network and its decentralized structure, current offers and sales of Ether are not securities transactions".[120]

218. Decentralized structure is an important feature in public blockchain operations and TON's consensus algorithm is designed to be more decentralized than comparable blockchains such as Bitcoin, Ethereum, and EOS. Decentralization is paramount to the value proposition of blockchains because the ability to manipulate the ledger is antithetical to the concept of a trustless and unambiguous source of truth. The whole point is that there is no essential manager.

219. The evidence in Section VII details the roles of various decentralized actors in TON's BFT Proof of Stake system, and Section X details the degree of centralization in Bitcoin, Ethereum, and EOS. Within PoW systems like Bitcoin and Ethereum, 51% is a critical threshold in terms of centralization of mining power because this is the amount of control required to unilaterally manipulate the ledger. As of this writing, as few as four mining pools in Bitcoin, and three mining pools in Ethereum, control more than 51% of the mining power collectively. With regards to EOS, the design of the voting mechanism used to elect block producers, who perform the primary operation of the network, is suboptimal in terms of decentralization. The evidence suggests that voting cartels are influencing the election of block producers.

220. In contrast, TON requires over 2/3 of validators to sign valid blocks, which equated to at least 67 of the 100 initial validators at the time of the contemplated mainnet launch, and is designed to increase to hundreds as the network develops. TON is not designed with a voting scheme similar to EOS and is designed to enable wide participation in the validation process.

[120] See: https://www.sec.gov/news/speech/speech-hinman-061418

Furthermore, neither Telegram, the TON Foundation (if it is created), nor Telegram employees are anticipated to use any Grams under their control for validation or governance.

221. As I describe in Section IX, Grams are designed to have similar economic uses to cryptocurrencies and utility tokens such as bitcoin, ether, EOS, and siacoins, none of which are regulated as securities. Grams are designed to function as a store of value and medium of exchange similar to Bitcoin. Upon mainnet launch they are intended to be used to purchase compute power for smart contracts like Ether. Grams are proposed to serve as staking assets as part of the TON validation process like EOS, and to be used as a method of payment for consumptive services like file storage similar to Siacoins.

222. Another similarity between TON and public blockchains such as Bitcoin, Ethereum, EOSIO, and Stellar is the open source nature of the codebase. The entire source code is freely available and can be replicated by anyone. Furthermore, third party developers cannot be excluded from developing upon, and using the functionality of, the core protocol. As I detail in Section VIII.C, there is substantial evidence of third-party development activity on TON, as is the case with other smart contract platforms like Ethereum and EOSIO.

223. The importance of third-party development activities becomes apparent in Section XI, which reviews evidence on sources of value creation. Academic literature by top scholars suggests that functionality improvements over time, and well as net transactional benefits, are what drive value for assets like Grams. The global ecosystem of third-party application developers will play a large role in determining the degree to which TON expands functionality beyond the use cases that are available at the time of the contemplated mainnet launch and the applications they build will influence whether Grams are adopted by consumers.

* * * * * * * * *

Respectfully submitted,

Dated: December 27, 2019

Stephen McKeon, Ph.D.

Appendix A: Documents Relied Upon

Telegram's Submissions to the SEC

Telegram Group Inc. Memorandum to the Staff of the SEC (June 26, 2018)

Telegram Group Inc. Supplemental Memorandum to the Staff of the SEC (Nov. 20, 2018)

Telegram Group Inc. Second Supplemental Memorandum to the Staff of the SEC (Feb. 27, 2019)

Telegram Group Inc. Third Supplemental Memorandum to the Staff of the SEC (Mar. 18, 2019)

Telegram Group Inc. Fourth Supplemental Memorandum to the Staff of the SEC (July 25, 2019)

Case-Related Documents

Complaint, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Oct. 11, 2019)

Plaintiff's Memorandum of Law in Support of Emergency Motion, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Oct. 11, 2019),

Declaration of Daphna A. Waxman, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Oct. 11, 2019) ("Waxman Declaration")

Ex. A to Waxman Declaration – Telegram Group Inc. and TON Issuer Inc Form D (Feb. 13, 2018)

Ex. B to Waxman Declaration – Telegram Group Inc. and TON Issuer Inc Form D (Mar. 29, 2018)

Ex. C to Waxman Declaration – Screenshot of "Celebrating 6 Years of Telegram" from Telegram's website, https://telegram.org/blog/6-years

Ex. D to Waxman Declaration – Screenshot of "Registration FAQ" from Telegram's website, https://telegram.org/faq

Ex. E to Waxman Declaration – 2017 Two Page Teaser

Ex. G to Waxman Declaration – 2017 Primer

Ex. H to Waxman Declaration – 2018 Pre-Sale Primer (TG-001-00000054)

Ex. I to Waxman Declaration – Telegram Open Network Technical White Paper (Dec. 3, 2017) (TG-004-00000026)

Ex. J to Waxman Declaration – Telegram Open Network Technical White Paper (Jan. 18, 2018) (TG-001-00000080)

Ex. K to Waxman Declaration – Telegram Open Network Blockchain (September 5, 2018) (TG-006-00000169)

Ex. R to Waxman Declaration – List of United States-based Grams purchasers (Jan. 9, 2017)

Ex. S to Waxman Declaration – List of non-United States-based Grams purchasers (Feb. 27, 2019)

Ex. T to Waxman Declaration – Draft Memorandum of Association of TON Foundation

Ex. U to Waxman Declaration – Letter from Telegram to SEC Staff (Oct. 3, 2019)

Ex. V to Waxman Declaration – Screenshot of YouTube video "Introduction to Gram Token Sale | Sale begins July 10 only on Liquid.com" (June 25, 2019), https://www.youtube.com/watch?v=-ChIcw-rtgt6Y

Ex. W to Waxman Declaration – Screenshot of Liquid's website (July 12, 2019)

Ex. Z to Waxman Declaration – "Coinbase continues to explore support for new digital assets", Medium (Sept. 19, 2019), also accessible at https://blog.coinbase.com/coinbase-continues-to-explore-support-for-new-digital-assets-70419575eac4

Ex. BB to Waxman Declaration – "Why Grams will be traded on Blackmoon?", Medium (Sept. 13, 2019), also accessible at https://news.blackmooncrypto.com/why-grams-will-be-traded-on-blacicmoon-4e2d57f83b62

Ex. CC to Waxman Declaration – Pre-Sale / Round 1 Purchase Agreement (TG-001-00000014)

Ex. DD to Waxman Declaration – Stage A / Round 2 Purchase Agreement (TG-003-00000223)

Ex. FF to Waxman Declaration – Certain Risks Associated with the Purchase, Sale and Use of Grams (TG-001-00000212)

Defendants' Answer, Defenses and Affirmative Defenses to Plaintiff's Complaint, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 12, 2019)

Stipulation and Protective Order, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 12, 2019)

Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, *SEC v. Telegram, et al.*, No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)

<u>Telegram's White Papers and Marketing Materials</u>

Telegram Open Network Virtual Machine (Sept. 5, 2018)

Telegram Open Network Development Status (Sept. 5, 2018)

Telegram Open Network Development Status (Jan. 28, 2019)

Telegram Open Network White Paper (Mar. 2, 2019)

Telegram Open Network Virtual Machine (Sept. 6, 2019)

Telegram Open Network Blockchain Validation (Oct. 2, 2019)

Telegram Open Network Blockchain (Oct. 3, 2019)

Fift A Brief Intro (Oct. 5, 2019)

2018 Stage A Primer (TG-003-00000056)

Other Documents

Buterin, Vitalik, and Virgil Griffith. "Casper the Friendly Finality Gadget." October 25, 2017. See: https://arxiv.org/pdf/1710.09437.pdf

Hanke, Timo, Mahnush Movahedi, and Dominic Williams. "DFINITY Technology Overview Series Consensus System." May 11, 2018. See: https://arxiv.org/pdf/1805.04548.pdf

"Industry Revolution Series Part I: The New Building Blocks: Moving Beyond Equities and Bonds, The Emergence of Robo-Beta & Democratizing Access to New Alpha Sources." Citi Business Advisory Services, 2018.

Investor List Provided by Counsel.

List of Third-Party dApps and Features.

Mazieres, David. "The Stellar Consensus Protocol: A Federated Model for Internet-level Consensus." February 25, 2016. See: https://www.stellar.org/papers/stellar-consensus-protocol.pdf

Moindrot, Olivier, and Charles Bournhonesque. "Proof of Stake Made Simple with Casper." Autumn, 2017. See: https://pdfs.semanticscholar.org/02fe/b6217d3a722773d9a971b2bbc80aa374ed95.pdf?_ga=2.213771091.616090777.1577470875-1571018687.1576694369

ORDER INSTITUTING CEASE-ANDDESIST PROCEEDINGS PURSUANT TO SECTION 8A OF THE SECURITIES ACT OF 1933, MAKING FINDINGS, AND IMPOSING A CEASE-AND-DESIST ORDER In the Matter of Nebulous, Inc., Respondent.

Simos, Elias "The Current State of Telegram Open Network: A sleeping giant awakens." October 2019. See: https://drive.google.com/file/d/1PCEypWk6Z4QLdyvhXm1CRk79pQ0Zkbkp/view

"Steem – An incentivized, blockchain-based, public content platform." June 2018. See: https://steem.com/steem-whitepaper.pdf

Vorick, David, and Luke Champine. "Sia: Simple Decentralized Storage." November 29, 2019. See: https://sia.tech/sia.pdf

"Wirecard and Telegram Open Network infrastructure developer TON Labs enter partnership", Wirecard press release (Apr. 17, 2019), https://www.wirecard.com/company/press-releases/wirecard-and-telegram-open-network-infrastructure-developer-ton-labs-enter-partnership

Academic Publications

Abadi, Joseph, and Markus Brunnermeier. 2018. Blockchain economics. No. w25407. National Bureau of Economic Research.

Akerlof, G.A., 1978. The market for "lemons": Quality uncertainty and the market mechanism. In Uncertainty in economics (pp. 235-251). Academic Press.

Arrow, K.J., 1972. Gifts and exchanges. Philosophy & Public Affairs, pp.343-362.

Benedetti, H., S. McKeon, and C. Pfiffer. 2019. 'Blockchain Trading'. In R. Rau, R. Wardrop and L. Zingales (eds), *Handbook of Technological Finance*, London, England: Palgrave Macmillan. Forthcoming.

Biais, Bruno, Christophe Bisiere, Matthieu Bouvard, Catherine Casamatta, and Albert J. Menkveld. "Equilibrium Bitcoin Pricing." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, October 5, 2018. https://papers.ssrn.com/abstract=3261063.

Briscoe, Bob, Andrew Odlyzko, and Benjamin Tilly. "Metcalfe's law is wrong-communications networks increase in value as they add members-but by how much?." IEEE Spectrum 43, no. 7 (2006): 34-39.

Burniske, Chris, and Arthur B. Laffer, 2015, retrieved from https://cdn2.hubspot.net/hubfs/533155/1_Download_Files_ARK-Invest/White_Papers/Bitcoin-Disruptive-Currency-ARKInvest.pdf

Canidio, Andrea. "Financial Incentives for Open Source Development: The Case of Blockchain." MPRA Paper. University Library of Munich, Germany, 2018. https://econpapers.repec.org/paper/pramprapa/85352.htm.

Cong, Lin William, Ye Li, and Neng Wang. "Tokenomics: Dynamic Adoption and Valuation." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, May 18, 2019. https://papers.ssrn.com/abstract=3222802.

Croman, K., Decker, C., Eyal, I., Gencer, A.E., Juels, A., Kosba, A., Miller, A., Saxena, P., Shi, E., Sirer, E.G. and Song, D., 2016, February. On scaling decentralized blockchains. In International Conference on Financial Cryptography and Data Security (pp. 106-125). Springer, Berlin, Heidelberg.

Eyal, I., & Sirer, E. G. (2018). Majority is not enough: Bitcoin mining is vulnerable. Communications of the ACM, 61(7), 95-102.

Fisher, Irving. 1930. Theory of interest: as determined by impatience to spend income and opportunity to invest it. Augustus M. Kelly Publishers, Clifton.

Gencer, Adem Efe, Soumya Basu, Ittay Eyal, Robbert Van Renesse, and Emin Gün Sirer. "Decentralization in bitcoin and ethereum networks." arXiv preprint arXiv:1801.03998 (2018).

Howell, Sabrina, Marina Niessner, and David Yermack. "Initial Coin Offerings: Financing Growth with Cryptocurrency Token Sales." *The Review of Financial Studies*. Accessed November 18, 2019. https://doi.org/10.1093/rfs/hhz131.

Huberman, Gur, Jacob Leshno, and Ciamac C. Moallemi. 2019. An economic analysis of the Bitcoin payment system. Columbia Business School Research Paper 17-92.

Johnson, Justin Pappas. 2002. Open source software: Private provision of a public good. Journal of Economics & Management Strategy 11, 637-662.

Lerner, Josh and Jean Tirole. 2002. Some simple economics of open source. The Journal of Industrial Economics 50, 197-234.

Lewellen, W. G., 1968. Executive compensation in large industrial corporations. National Bureau of Economic Research, New York.

Li, Jiasun, and William Mann. "Initial Coin Offerings and Platform Building." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, October 1, 2018. https://papers.ssrn.com/abstract=3088726.

McKeon, S. and D. Schloss. 2019. 'Law and Blockchain'. In R. Rau, R. Wardrop and L. Zingales (eds), *Handbook of Technological Finance*, London, England: Palgrave Macmillan. Forthcoming.

Pagnotta, Emiliano, and Andrea Buraschi. "An Equilibrium Valuation of Bitcoin and Decentralized Network Assets." SSRN Scholarly Paper. Rochester, NY: Social Science Research Network, March 21, 2018. https://papers.ssrn.com/abstract=3142022.

Williams, John Burr. 1938. The theory of investment value. No. HG4521 W48.

Zimmerman, Peter. 2019. Blockchain structure and cryptocurrency prices. Mimeo, Oxford University.

Zucker, L.G., 1986. Production of trust: Institutional sources of economic structure, 1840-1920. Research in organizational behavior, 8, pp.53

Appendix B: Valuation methodologies

1. Innovation in asset structures often precedes valuation methodologies. For example, expectations of future cash flows have been understood to be relevant for cash flow generating assets such as stocks and bonds for centuries, but the discounted cash flow method was not formally expressed until the 1930's.[1] Similarly, the Black-Scholes formula, developed in the early 1970s, is widely used as a valuation methodology for financial options today, but stock options constituted as much as 1/3 of total compensation for managers of large manufacturing companies as far back as 1955 (Lewellen, 1968). In this section, I review current approaches to valuation of cryptocurrencies and utility tokens with the caveat that widely accepted methodologies remain elusive at this nascent stage and are the subject of considerable debate.

1. Approaches based on market size and velocity

2. Burniske and Laffer (2015) offer an early attempt at cryptocurrency valuation, focusing on Bitcoin which was the only meaningful cryptocurrency at the time. The application of this method consists of first identifying a market or asset that may be disrupted by Bitcoin in the sense that Bitcoin would replace some percentage of the economic activity. For markets involving flows a velocity parameter (how many times the asset changes hands per year) is also needed. Burniske and Laffer focus on the remittances market and the market for investable gold. With regards to remittances, they cite a World Bank figure of $426 billion as the total value of remittances in 2014 to developing countries. They use a velocity figure of 1.5, comparable to the U.S. Dollar MZM (Money with Zero Maturity) velocity and there were approximately 14.2M bitcoin outstanding as of the time of writing. Thus, if Bitcoin were to capture 10% of the

[1] Fisher (1930) and Williams (1938).

remittance market, it leads to a valuation estimate per coin of $2,000 ($426B*0.10/1.5/14.2M). Similarly, if Bitcoin were to be valued equivalently to 1% of aggregate value of investable gold ($2.5 trillion) then the valuation methodology would suggest a price per coin of $1,760 ($2.5T*0.01/14.2M).

3. Clearly, this method leaves out important considerations that would be required to arrive at a current valuation estimate, such as how far in the future the estimated level of market capture occurs. However, it introduced two important determinants: potential market size of use cases for the asset, and the rate of turnover of the asset (velocity).

4. Burniske (2017)[2] acknowledges some of the shortcomings of the 2015 approach and offers another variant based on the equation of exchange: MV=PQ, and applies it to a utility token context. PQ is price times quantity of the specific good provisioned by the network, for example file storage for Sia. V is velocity and Burniske raises his estimates of this parameter relative to the 2015 article. M is the total network value, which is divided by some measure of tokens outstanding. Burniske also applies a discount factor to account for the fact that the projection of PQ occurs in the future and is subject to considerable uncertainty. Numerous articles since have been written about MV=PQ and common criticisms include the challenges around estimating V and the discount rate. At a high level, one can view the methodology as pointing towards network functionality (PQ) and network design (V) as determinants of value.

2. Relative Valuation Methods

5. A second class of valuation methodologies are related to relative valuation measures for traditional assets, often referred to as comparable analysis, or "comps." This method

[2] See: https://medium.com/@cburniske/cryptoasset-valuations-ac83479ffca7

employs a ratio where a measure of value for the target is used in the numerator and a value relevant attribute of the target appears in the denominator. If the market values the attribute consistently across assets in the cross-section, then:

$$\frac{Value_{i,t}}{Attribute_{i,t}} = \frac{Value_{j,t}}{Attribute_{j,t}}$$

6. Alternatively, if the market values the attribute consistently for a single asset in the time series, then:

$$\frac{Value_{i,t-1}}{Attribute_{i,t-1}} = \frac{Value_{i,t}}{Attribute_{i,t}}$$

7. In cash flow generating assets like corporate equity, enterprise value or equity market capitalization are typically used in the numerator and a measure of financial performance such as revenue or earnings is used in the denominator.

8. For cryptoasset networks, the most common ratio I have observed in analyst reports is the NVT ratio:

$$\frac{Network\ Value}{Value\ of\ On - chain\ Transactions}$$

9. Network value is measured as number of tokens outstanding (treasury is typically excluded) and value of on-chain transactions can be measured over any interval, a 30-day moving average is a common choice. Analysts typically compare this ratio both across different assets as well as in the time series for a particular asset.

10. The belief that on-chain transactions are value relevant is consistent with the volume of consumptive uses being value relevant. Trading activity that occurs off-chain at

centralized trading venues would not enter the denominator. However, it is important to note that movements of assets between exchange wallets would appear on-chain.

11. Another version of this analysis utilizes a measure of active addresses (wallets) as the value relevant attribute. Ratios based on active addresses draw inspiration from Metcalfe's Law and Odlyzko's Law, both of which assert that the value of a communications network grows in proportion to the number of users, but at a greater than linear rate. In other words, if the number of users doubles, the value of the network more than doubles.

Appendix C: Description of Ethereum

Ethereum Foundation Overview

1. The Ethereum Foundation describes its mission as follows: "to promote and support Ethereum platform and base layer research, development and education to bring decentralized protocols and tools to the world that empower developers to produce next generation decentralized applications (dapps)."[1] Therefore, the two key activities pertaining to the role of the Ethereum Foundation within the Ethereum blockchain and its ecosystem are (1) providing support for the platform and base layer research and (2) developing decentralized protocols and tools to empower developers in the creation of dApps. Such objectives are pursued through the development activities and funding provisions of the Ethereum Foundation, which is made up of approximately 90 people in 7 teams working on the following areas:[2]

- Research, mainly on Ethereum 2.0 (including Casper and sharding[3, 4]) – the network's transition from PoW to PoS
- Geth client – a popular Ethereum node client
- WASM – a compiler of high-level languages for enabling web deployment
- Whisper – a protocol for dApps to communicate with one another
- Swarm – a distributed storage platform
- Pyevm – a Python implementation for the Ethereum Virtual Machine
- Trinity – a client for the Ethereum blockchain
- Vyper – a contract-oriented pythonic programming language

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[1] See: https://docs.ethhub.io/ethereum-basics/ethereum-foundation/
[2] *Id.*
[3] Sharding is a method of splitting and storing a single logical dataset in multiple databases.
[4] See: https://www.reddit.com/r/ethereum/comments/95h4io/how_many_people_work_for_ethereum_foundation/e3sv72e/

- Solidity – a contract-oriented programming language native to Ethereum
- Developer tools – a range of toolkits for developers to build on the Ethereum blockchain

Ethereum History

2. The Ethereum open testnet,[5] known as Olympic, was launched in May 2015. For a period of approximately 3 months, developers were invited to stress-test the network. In July 2015, Frontier, the Ethereum mainnet,[6] was launched and the genesis block was mined into existence. The platform included what were known as canary contracts, which were specifically designed to notify users of vulnerabilities in a particular chain, and alert miners not to mine a broken chain. Canary contracts gave the Ethereum core developer group the ability to stop an operation or transaction on the network, if something went wrong. According to Consensys, these contracts were heavily centralized but were nevertheless a necessary mechanism to protect Ethereum.[7]

3. The need for such mechanisms at the early stage of Ethereum suggests that initially, a degree of centralization was required on the Ethereum network to ensure that the it was operating as intended, as a means to reduce system vulnerability and facilitate a smooth on-boarding of developers and users. I understand the network at the time was considered usable, but its capabilities were largely limited to people with existing knowledge and experience with Ethereum.[8] Such limitations suggest that early stage blockchain platforms are primarily accessible to developers with pre-existing knowledge, namely developers involved in the platform's creation,

[5] A software that is identical to the software used by a cryptocurrency, which is used for testing.
[6] The live network where cryptocurrency transactions occur on a distributed ledger.
[7] See: https://consensys.net/blog/blockchain-explained/a-short-history-of-ethereum/
[8] *Id.*

therefore, there may be a certain time requirement for adoption to be substantive enough to reach a true level of decentralization.

4. In March 2016, Homestead, Ethereum's first planned fork[9] was implemented and introduced a few major improvements: (1) the removal of the canary contracts and the associated point of centralization, (2) introduced new codes in Solidity,[10] (3) introduced the Mist wallet,[11] which allowed users to transact with ETH and deploy smart contracts and (4) implemented Ethereum Improvement Proposals ("EIP"). EIPs are recommendations made by the developer community, which if approved, are included in network upgrades.[12]

5. In October 2017, Byzantium, the first phase of the Metropolis stage, went live. The most notable change was the implementation of the difficulty bomb, which was a necessary step in the transition from PoW to PoS. A difficulty bomb was designed to elevate the difficulty of mining until it became impossible to mine anymore. Doing so, would prevent a potential fork in the blockchain, in the occasion that participants decided to continue utilizing PoW instead of transitioning to a PoS mechanism.[13]

6. In February 2019, Constantinople, the second phase of the Metropolis stage, was implemented to improve speed and scalability. Notable changes included: (1) lateral movement of information, which made the execution of shifts in smart contracts ten times cheaper, (2) ability of smart contracts to verify one another by pulling only the hash of a smart contract, thus reducing processing time and costs and (3) implemented scaling solutions based on off-chain transactions.[14] Almost 4 years after Ethereum's launch, improvements are still being made to the platform with

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[9] A radical change to a network's protocol that makes previously invalid blocks and transactions valid, or vice versa.
[10] A programming language oriented at implementing smart contracts on the Ethereum blockchain.
[11] A digital wallet used for storage and the execution of transactions on the Ethereum network.
[12] See: https://consensys.net/blog/blockchain-explained/a-short-history-of-ethereum/
[13] *Id.*
[14] *Id.*

the purpose of enhancing speed and scalability, in order to increase adoption, grow the ecosystem and ensure its long-term success. Such improvements are mainly driven by the Ethereum Foundation and the Ethereum core developer team.

7. In December 2019, Istanbul went live. Istanbul, the third phase of Metropolis, is the final planned fork update before Ethereum begins the implementation of Serenity, the transition from PoW to PoS. Notable changes implemented include: (1) improved attack resilience, (2) improved interoperability with other cryptocurrencies and (3) improved scalability.[15] An additional component of Istanbul, scheduled for implementation in 2020, includes the Programmatic Proof of Work ("ProgPoW"), which is designed to reduce the efficiency gap created by the use of ASICs processors (as compared to GPU processors), consequently balancing the opportunity to mine ETH by all participants in order to enhance decentralization. The decision to implement ProgPoW, which has been received amidst controversy, was made at an Ethereum core developers meeting in August 2019, where six EIPs were approved and eight EIPs were tentatively approved.[16] Interestingly, even though Ethereum is currently considered to be a decentralized network, an assessment put forth by the SEC's Mr. Hinman, as outlined above, the decision for Ethereum to implement ProgPoW, was nevertheless made under the administrative control of the Ethereum core developer team.

[15] See: https://consensys.net/blog/news/everything-you-need-to-know-about-the-istanbul-hard-fork/

[16] See: https://lunardigitalassets.com/news/project-news/ethereum/ethereum-devs-to-implement-progpow-istanbul-hardfork/

Ethereum Expected Future Development

8. The Ethereum Foundation has outlined its plans to continue to improve the platform for its objectives of scalability, decentralization, and energy efficiency.[17] Serenity, also known as Ethereum 2.0, is the official name of the stage during which the network will initiate the transition from PoW to PoS. It is comprised of 4 phases: (1) Beacon Chain (Phase 0), (2) Shard Chain (Phase 1), (3) State Execution (Phase 2) and (4) continued improvements (Phase 3) .[18] The Serenity stage of Ethereum will be originally underpinned by Casper FFG, a PoW/PoS hybrid consensus protocol[19] utilizing Practical Byzantine Fault Tolerance.[20] Casper FFG is designed to increase scalability and enhance decentralization on the network. Serenity Phase 0 will mark the introduction of PoS and set the foundations for shardchains on the Ethereum network. Phase 1 will introduce and test the implementation of shardchains on the network. Phase 2 will introduce a new virtual machine, known as the Ethereum-flavored Web Assembly ("eWASM"). During this phase, shardchains will evolve and become fully functional, capable of scaling the network. The introduction of eWASM, Ethereum's new virtual machine will allow contracts written in multiple different programming languages to be implemented on the network. Finally, Phase 3 will be comprised of additional improvements to the blockchain, including light client state protocol, coupling with mainchain security and super quadratic sharding.[21]

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[17] See: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/eth-2.0-phases/
[18] *Id.*
[19] See: https://education.district0x.io/general-topics/ethereum-scaling/what-is-casper/
[20] See: https://medium.com/unitychain/intro-to-casper-ffg-9ed944d98b2d
[21] See: https://consensys.net/blog/blockchain-explained/the-roadmap-to-serenity-2/

Exhibit 1: Curriculum Vitae of Stephen McKeon

Stephen B. McKeon

Lundquist College of Business
1208 University of Oregon
Eugene, OR 97403-1208
Ph: (541) 346-8556
smckeon@uoregon.edu

Birthplace: Minneapolis, MN

Education

PhD, Management (Finance), Purdue University	2011
MS, Economics, Purdue University	2009
BS, Business Administration, University of Oregon	2000

Academic Positions

University of Oregon, Lundquist College of Business
- Associate Professor of Finance — 2017 - Present
- Inman Research Scholar — 2018 - Present
- Assistant Professor of Finance — 2011 - 2017

University of Cambridge, Cambridge Centre for Alternative Finance
- Visiting Associate — 2019-2020

University of California, Berkeley
- Lecturer in "Blockchain Unlocked" executive education program — 2017-2018

Purdue University, Krannert School of Management
- Graduate Student Instructor — 2009

Research

Published Articles:

"Intermediation in Private Equity: The Role of Placement Agents," *Journal of Financial and Quantitative Analysis* (forthcoming), with Matthew D. Cain and Steven Davidoff Solomon

"Banking on Stone Money: Ancient Antecedents to Bitcoin," *Economic Anthropology* (forthcoming), with Scott Fitzpatrick

"Do Takeover Laws Matter? Evidence from Five Decades of Hostile Takeovers," *Journal of Financial Economics* 124 (June 2017), with Matthew D. Cain and Steven Davidoff Solomon

"Proactive Leverage Increases and the Value of Financial Flexibility," *Journal of Applied Corporate Finance* 28 (Fall 2016), 17-28, with David J. Denis

Research (cont.)

Published Articles (cont.):

"CEO Personal Risk-Taking and Corporate Policies," *Journal of Financial and Quantitative Analysis* 51 (February 2016), 139-164, with Matthew D. Cain

"Debt Financing and Financial Flexibility: Evidence from Pro-active Leverage Increases," *Review of Financial Studies* 25 (June 2012), 1897-1929, with David J. Denis

Publications in edited books:

"Corporate Governance and Ownership Structure" in Corporate Governance, Eds. H. Kent Baker and Ronald Anderson, (John Wiley & Sons, Inc., 2010), with John J. McConnell and Wei Xu

Working papers:

Persistent Operating Losses and Corporate Policies (*with D Denis*)
2nd round Revise and Resubmit at *Journal of Financial Economics*

Law and Blockchains, forthcoming in *Palgrave-MacMillan Handbook of Technological Finance*

Blockchain Trading and Exchange, forthcoming in *Palgrave-MacMillan Handbook of Technological Finance*

Employee Option Exercise and Equity Issuance Motives

Work-in-progress:

Blockchain Asset Ratings and Returns (*with Baixiao Liu*)

Research Presentations and Discussions

*(Scheduled presentations in italics, * indicates presentation by co-author)*

Invited presentations

"Persistent Operating Losses"

2017 UC Berkeley Law, Accounting, and Business Workshop
2017 SFS Finance Cavalcade (Nashville)*
2017 FSU SunTrust Conference (Miramar Beach, FL)
2017 Seminar at University of Illinois, Chicago
2016 Pacific Northwest Finance Conference (Seattle)
2016 Seminar at University of Wisconsin, Milwaukee

"Intermediation in Private Equity"

2015 Private Equity Research Consortium (PERC) Conference (Chapel Hill, NC)
2015 Conference in honor of John McConnell's contributions to finance (W. Lafayette, IN)
2015 Seminar at Universidad de los Andes (Santiago, Chile)
2015 American Finance Association (Boston)*
2014 American Law and Economics Association (Chicago)*
2014 Argentum Centre for Private Equity Symposium (Bergen, Norway) *

Research Presentations and Discussions (cont.)

Invited presentations (cont.)

"Do Takeover Laws Matter?"

2015 American Finance Association (Boston)
2014 American Law and Economics Association (Chicago)*
2014 FSU SunTrust Conference (Miramar Beach, FL)

"Employee Option Exercise and Equity Issuance Motives"

2013 SFS Finance Cavalcade (Miami, FL)
2013 European Finance Association (Cambridge, UK)
2012 Financial Research Association (Las Vegas, NV)
- *Barclay Award*
2011 Pacific Northwest Finance Conference (Seattle, WA)
2010 FMA Doctoral Student Consortium (New York, NY)

"CEO Risk-Taking and Corporate Policies"

2012 UniSA Behavioral Finance and Capital Markets Conference (Adelaide, Australia)
-*Best Paper – Early Career Researcher*
2012 LCB Board of Advisors meeting (Eugene, OR)
2012 CJP annual convention (Coeur d'Alene, ID)
2012 Annual Meeting of the Academy of Behavioral Finance & Economics (New York, NY)
2011 University of Miami Behavioral Finance Conference (Miami, FL)
2011 Krannert Dean's Advisory Council (W. Lafayette, IN)
2011 Job Market seminar at University of Oregon (Eugene, OR)
2011 Northern Finance Association (Vancouver, BC)
2010 IU-Purdue-Notre Dame Finance Conference (Bloomington, IN)*

"Debt Financing and Financial Flexibility"

2010 American Finance Association (Atlanta, GA)
2010 Research Conference in Recognition of the Scholarly Contributions of Larry Y. Dann (UO)

Invited discussions

2019 Financial Management Association (New Orleans, LA)
2016 Financial Management Association (Las Vegas, NV)
2013 European Finance Association (Cambridge, UK)
2012 Annual Meeting of the Academy of Behavioral Finance & Economics (New York, NY)
2011 Northern Finance Association (Vancouver, BC)

Other speaking engagements

2019 Consensus Invest (New York, NY)
2019 Fluidity Summit (New York, NY)
2019 Digital Asset Summit (New York, NY)
2018 Wharton Reg@Tech (Philadelphia, PA)
2018 Security Token Summit (New York, NY)
2017 UC Berkeley "Blockchain Unlocked" program, sessions on blockchain regulation, stablecoins, and tokenized securities (Berkeley, CA)
2017 Wall Street Blockchain Alliance (New York, NY)

Courses Taught

University of Oregon:
FIN316: Financial Management (Undergrad Core)
FIN409: Practicum – U of O Investment Group (Undergrad Elective)
FIN473: Financial Analysis and Valuation (Undergrad Elective)
FIN609: Practicum – Emerging Markets Fund (MBA/MSF)
FIN610: Venture Capital and Cryptoassets (MBA/MSF)
FIN612: Fundamentals of Finance (MBA Core)
FIN673: Advanced Topics in Corporate Finance (MBA Elective)
FIN607: Seminar in Corporate Finance (PhD)
Sessions on blockchain regulation, and token economics (Exec Ed)

University of California, Berkeley:
Sessions on blockchain regulation, and token economics (Exec Ed)

University of Cambridge:
Sessions on blockchain regulation, and token economics (Exec Ed)

Popular Press Citations and Appearances

Print/Blog: *Wall Street Journal, Bloomberg BusinessWeek, Financial Times, NY Times (Dealbook), TheStreet.com, Forbes, MarketWatch, Reuters, Smart Money, Maclean's, Baltimore Sun, Harvard Corporate Governance blog, MIT Technology Review*

TV/Video/Radio: CNBC, WSJ "Lunch Break", Fox Business News, NPR – StateImpact,

Podcasts: Capital Allocators, Venture Stories, The Bitcoin Podcast Network, Eric Jackson podcast, The Flippening, Coin Crunch

Full media list available here: https://goo.gl/eL4udx

Awards and Scholarships

Research Awards:

Inman Research Scholar	2018-2020
Dean's Scholar Research Award	2015-2017
Kageyama Endowment Fund Award	2013, 2016
Financial Research Association Michael J. Barclay Award	2012
Best Paper – Early Career Researcher – Capital Markets CMC	2012
Purdue Research Foundation Grant	2010 – 2011

Teaching Awards:

Ersted Award for Distinguished Teaching (Highest UO Teaching Award)	2016
James E. Reinmuth MBA Teaching Excellence Award	2013,14,15,16,17,18
Business Advisory Council Undergraduate Teaching Award	2012, 2015
Krannert Certificate for Distinguished Teaching	2009

Other Awards:

Harry R. Jacobs, Jr. Professional Service Award	2015, 18
Fredrick N. Andrews Fellowship, Purdue University	2007 – 2009

Professional Service

Ad hoc referee: *Journal of Finance, Journal of Financial Economics, Review of Financial Studies, Journal of Financial and Quantitative Analysis, Management Science, Journal of Corporate Finance, Journal of Banking and Finance, Journal of Empirical Finance, Economics Letters*

Service to School

MBA Academic Committee (Chair)	2017-Present
Emerging Markets Fund faculty advisor	2017-Present
MSF Academic Committee	2018-Present
Quack Chats speaker	2018
UO Investment Group faculty advisor	2013-14, 2015-16
UO Foundation Seed Fund faculty advisor	2014-2016
Course coordinator (FIN316)	2012 – 2015
Undergraduate program committee	2013 – 2015
MBA director search committee	2014, 2015
Wealth management panel moderator	2014
New Major Celebration keynote speaker	2013
UOIG NY Trip coordinator	2012, 2013, 2015
Duck Days faculty speaker	2013, 2014
UOIG alumni reunion coordinator	2012
Accounting Dept. faculty search committee	2012
LCB Board of Advisors speaker	2012
LCB faculty seminar series speaker	2011
Officer, Krannert Doctoral Student Association	2008 – 2010
Emerging Leaders Group, LCB-University of Oregon	2006 – 2008

Service on Dissertation Committees

Student, Placement, Year

Arash Dayani, In-progress, exp. 2020
Chad Fulton, Board of Governors, Federal Reserve, 2016 (outside member)
Hai Tran, Loyola Marymount, 2015
Andrea Anthony, Oregon State, 2014 (co-chair)

Industry Positions

Partner, Collaborative Fund	2018-Present
Chief Strategy Advisor, Security Token Academy	2018-2019
Co-founder, Coast to Crest Fund, Eugene, OR	Founded 2017
Co-founder, Skyworks Development Group, Portland, OR	Founded 2017
Co-founder, Carmel Wine Company, Carmel-by-the-Sea, CA	Founded 2013
Co-founder, Skyward, Portland, OR	Founded 2012
Board of Directors, Stratus Digital Systems, Eugene, OR	2015-2018
Chief Financial Officer, Greenfield Wine Company, American Canyon, CA	2001-2007

Exhibit 2: List of Potential Validators at Launch (Purchasers in Round 2)

[redacted]

Exhibit 2: List of Potential Validators at Launch (Purchasers in Round 2)

[redacted]

Exhibit 2: List of Potential Validators at Launch (Purchasers in Round 2)

[redacted]

Exhibit 3: Staking as a Service Providers

Source: https://www.stakingrewards.com/providers

#	Name	Number of Assets Supported for Staking	Source
1	Everstake	18	https://everstake.one/
2	Gentarium	17	https://mn.gtmcoin.io/
3	KuCoin	16	https://www.kucoin.com/staking
4	Staked	16	https://staked.us/
5	HashQuark	15	https://www.hashquark.io/#/
6	Wetez	15	https://www.wetez.io/pc/wetez
7	InfStones	14	https://infstones.io/staking/
8	Binance	13	https://www.binance.com/nl/staking
9	01node	13	https://01node.com/
10	Figment Network	13	https://figment.network/
11	Btcpop	13	https://btcpop.co/home.php
12	Blockdaemon	12	https://blockdaemon.com/
13	EON Capital	12	https://eon.capital/
14	SNZPool	11	https://snzholding.com/pool.html
15	MyCointainer	10	https://www.mycointainer.com/
16	Stake Fish	8	https://stake.fish/en/#network
17	P2P Validator	8	https://p2p.org/
18	OKEX	7	https://www.okex.com/pool/lock/index
19	Stake Capital	7	https://www.stake.capital/
20	Cobo	7	https://cobo.com/
21	BisonTrails	6	https://bisontrails.co/
22	POS Bakerz	6	https://posbakerz.com/
23	Zednode	6	https://zednode.com/
24	HyperPay	6	https://www.hyperpay.tech/pos?lang=en
25	Dokia Capital	5	https://staking.dokia.cloud/
26	Cypher Core	5	http://cyphercore.io/
27	Staking Facilities	5	https://stakingfacilities.com/
28	Forbole	5	https://www.forbole.com/cosmos-hub-validator/
29	Certus	4	https://certus.one/delegate
30	Chorus	4	https://www.chorus.one/
31	Hyperblocks	4	https://hyperblocks.pro/
32	StackOfStake	4	https://stackofstake.com/Home/HowItWorks
33	Cake	4	https://pool.cakedefi.com/#/

Exhibit 3: Staking as a Service Providers

Source: https://www.stakingrewards.com/providers

#	Name	Number of Assets Supported for Staking	Source
34	Midas.Investments	4	https //midas investmen s/
35	ChainLayer	4	https:// www ch inlaver.io/
36	Stakecube	4	https://stakecube.net/
37	Stir Waves	4	https://stir.network/waves/
38	Bitcat	4	https://www.bitcat365.com/en/
39	Huobi	3	https://www huobiwallet.com/en taking/
40	StakeWithUs	3	https://atlas sta ewith us/
41	Trust Wallet	3	https://platform tustwall t com/
42	Consensus Networks	3	https://consensusnetworks com/
43	Stakinglab	3	https://stakingteam.com/
44	Cryptium Labs	3	https://cryptium.ch/
45	Stakebase	3	https://stakebase com/
46	Mythos	2	https://mythos services/
47	Velic	2	https://www velic io/
48	Simple POS Pool	2	https://simpleposppool.com/
49	4Stake	2	https://www.4stake.com/?lan =en
50	MathWallet	2	https://www.mathwall t or g/en/
51	Anchorage	2	https://anchor ge.com/
52	BitGo	2	https:// ww.bitgo.com/services/staking
53	Kraken	1	https://w w kraken com/en us/
54	Coinbase	1	https://custody.coinba e com/
55	Poloniex	1	https://poloniex.com/
56	IDEX E change	1	https://ide market/staking
57	Sesameseed	1	https://www sesameseed.org/
58	PureStake	1	https://www.purestake.com/
59	StakeNow	1	https //stakeno de/
60	Bake n'Rolls	1	https://bakenrolls.com/
61	Liebi Pool	1	https://pool.liebi.com/
62	Bitcoin Suisse	1	https://www.bitcoinsuisse.com/staking
63	Spark Pool	1	http //www.sparkpool.com/en/
64	Iqlusion	1	https://www.iqlusion.io/
65	MATPool	1	https://matpool.io/
66	Stakery	1	https://stakery.io/

Exhibit 4: List of Third-Party dApps and Features

#	Name	Developer	Notes Based on Third Party Description	Link(s)
1	SOL2TVM compiler	TON Labs	Tool to ensure contract compatibility between Ethereum platform and TON Virtual Machine	https://www.coindesk.com/telegrams-blockchain-will-be-compatible-with-ethereum-ton-labs-says https://cryptobriefing.com/telegram-ton-labs/ https://cointelegraph.com/news/report-telegrams-ton-blockchainto-be-compatible-with-ethereumdapps https://docs.ton.dev/86757ecb2/p/04a4ba
2	LLVM compiler	TON Labs	LLVM-based compiler designed to convert sources from multiple high-level languages into its IR and then into TVM bytecode	https://ton.dev/toolchain https://docs.ton.dev/86757ecb2/p/04a4ba
3	TON Labs Local Node	TON Labs	TON Labs proprietary implementation of TON Node	https://ton.dev/node-se https://docs.ton.dev/86757ecb2/p /04a4ba
4	TON Labs SDK	TON Labs	CLI tool for streamlined usage	https://ton.dev/node-se https://docs.ton.dev/86757ecb2/p /04a4ba
5	TON Labs Toolchain	TON Labs	Compiler kit with the latest versions of	https://ton.dev/node-se
6	Ton Labs Node SE	TON Labs	Provides a set of developer tools to	https://ton.dev/node-se
7	Button Wallet	Button	Wallet that supports BTC, ETH, LTC, BCH, ETC, Waves, Stellar Lumens (XLM) and ERC-20 tokens; will facilitate exchange of Grams for other cryptocurrencies	https://www.forbes.com/sites/bill ybambrough/2019/08/26/telegra ms-300-million-users-could- soon-be-trading-bitcoin-and- cryptodespite-serious-security-warning/#1aa7fb523fe9 https://buttonwallet.com/
8	Mercuryo Pay	Mercuryo	Allows customers to pay with BTC & ETH; will process Grams once TON Blockchain launches	https://mercuryo.io/business/acq uiring/
9	AdGram	AdGram	Advertising platform that allows advertisers to create advertising campaigns and channel owners to monetize their audience	https://adgram.io/
10	BeProducers	BeProducers	Facilitates production of films for Gram holders	https://beproducer.pro/news-and-analytics/d1f08a5e-262f-48d3- 87bc-020530e2317d
11	TON dApps Marketplace	CryptoBazar	Includes pre-selected projects to be launched on TON Blockchain	https://ton.cryptobazar.io/
12	Drimsim SIM	Drimsim Global	Universal SIM and mobile expense card	https://m.facebook.com/3349089 50536095/posts/4329058174030 74?d=n&substory_index=0&sfns =mo https://twitter.com/drimsimgloba l/status/1197175207649304577? s=21 https://blog.drimsim.com/drimsi m-budet-prinimat-crypto-gram

Exhibit 4: List of Third-Party dApps and Features

#	Name	Developer	Notes Based on Third Party Description	Link(s)
13	Denim	Denim	Dating application for TON Blockchain	https://dcntrlzd.app/2019/11/17/denim/
14	Unovis	Unovis Forum	Marketplace for art using TON Blockchain	https://dcntrlzd.app/2019/10/23/unovis/
15	DareApp	Eristica	Mobile video platform	https://dcntrlzd.app/2019/10/13/dareapp/
16	Posh.space	Posh.space	Digital fashion store	https://dcntrlzd.app/2019/10/12/poshspace/ https://posh.space/
17	Pregnancy Tracker	Mobile Dimension	Pregnancy r[illegible]d app	https://dcntrlzd.app/2019/10/10/pregnancy-
18	U-Robot	U-robot	Chat-bot app; customized online store	https://dcntrlzd.app/2019/10/09/urobot/
19	Incognito	Incognito	Mobile network related app	https://dcntrlzd.app/2019/10/08/incognito/
20	Kelvpn	Kelvpn	VPN marketplace operating on top of decentralized network	https://dcntrlzd.app/2019/10/07/kelvpn/ https://kelvpn.com/
21	EzDapps	Apla	Dapps Marketplace	https://dcntrlzd.app/2019/10/06/ezapps/
22	Spatium	Spatium	Wallet with enterprise-level security	https://dcntrlzd.app/2019/10/05/spatium/ https://spatium.net/
23	Viewst	Viewst	Uses micropayments channel network to accept payments from users on TON Blockchain network as well as from other services; uses file-distributed storage technology for keeping assets and optimizing storage for large video files; provides optimized templates to create digital graphic assets for Telegram channels and other TON Services	https://viewst.com/
24	Worldwide Hackathon	Optimal.one	Worldwide Hackathon for the promotion of TON Blockchain projects	http://www.optimal.one/
25	ParJar	Parachute	Allows users to send cryptocurrency tips on Telegram	https://beincrypto.com/cryptocur rency-tips-on-telegram-reach- 500000-milestone-in-just-a-year/
26	TON-based real-time advertising platform	Appreciate	Proposed real-time advertising platform on top of TON Blockchain	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
27	copperbits/TO N	Copperbits (on GitHub)	R&D group focused on TON Blockchain on GitHub	https://github.com/copperbits/TO N https://t.me/ton_research
28	TON.Broxus	Finex Future	Java wrapper for TON	https://github.com/broxus/ton- client
29	Atomic TON Wallet	Atomic	Universal cryptocurrency wallet	https://atomicwallet.io/ton-wallet

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#	Name	Developer	Notes Based on Third Party Description	Link(s)
30	TON_tokens	Emelyanenko K	Simple tokens for TON	https://github.com/EmelyanenkoK/TON_tokens
31	ton_client	formony	Python API client for TON	https://github.com/formony/ton_client
32	TON Watcher	TON Center	Will allow users to search for addresses or blocks on TON Blockchain	https://tonwatcher.com/
33	TON.shi Public API	TON.sh	HTTP-based experimental interface for developers; explorer to search for addresses or transactions on TON Blockchain	https://ton.sh/api
34	Everstake	Everstake	Staking service platform	https://everstake.one/
35	Gett	Gett	On-demand mobility	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
36	Unknown	Achieve	Digital marketing	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
37	Unknown	Telefonica	Telecommunications	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
38	Unknown	Payfone	Trust platform	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
39	Unknown	PrivatBank	Payment services	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
40	Unknown	KupiBilet	Online travel platform	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
41	Unknown	WEBPAY	Payment services	Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, SEC v. Telegram, et al., No. 19-cv-9439(PKC) (S.D.N.Y. Nov. 22, 2019)
42	TON Auction	Denis Olshin	Multi-purpose smart-contract for TON blockchain implementing both an auction system and a shop	https://github.com/deNULL/ton-auction

Exhibit 4: List of Third-Party dApps and Features

#	Name	Developer	Notes Based on Third Party Description	Link(s)
43	Goods purchasing ecosystem project	Andrei Marchenko	Project creates an ecosystem for selling and purchasing goods on TON blockchain	https://github.com/ftkvyn/ton-goods
44	School register project	Andrei Marchenko	Project implements a register for giving grades to students in a school or university	https://github.com/ftkvyn/ton-register
45	TRC20 Token	Github user	A standard interface for tokens in TON (like ERC20 in Etherium)	https://github.com/cod1ng-studio/TRC20 https://tontalk.org/threads/184/
46	TON Lotto	@combot / TON.sh	Lottery bot for TON testnet implemented as a Telegram bot that interacts with the TON smart contract	https://tontalk.org/threads/156/
47	The Chat Game	EmelyanenkoK	RPG game with random items drop based on activity in chat rooms	https://ton.sh/e/tcg https://github.com/EmelyanenkoK/TheChatGame
48	OracleHub	EmelyanenkoK	Data provider platform that aims to create transparent registry of independent oracles	https://github.com/EmelyanenkoK/OracleHub
49	TON Mixer	@dkaraush	Project tries to transfer Grams through mixer nodes so they cannot be tracked in the open network	https://tonweb.site/-1:2bcc9840e7b9ec6b77fe3543b4eefbf3ba6c69fd98f362b3d3b2f4b752adb5e8/index.html https://github.com/dkaraush/ton-mixer
50	dApp for TON that allows delegation of GRAMs to validators in non-custodial way	BUTTON Wallet team	Project allows anyone to create delegation pool and become validator; allows anyone to earn interest by delegating Grams to potential Validators. (Risks will be handled by reputation system and security deposits); non-custodial web-based solution	https://github.com/button-tech/ton-delegation-pool
51	TON Decentralized Exchange	Github user	Implements a fully decentralized exchange with the support of the exchange of grams, extra currencies and TRC20 tokens	https://github.com/cod1ng-studio/ton-exchange
52	A Charity Foundation TON Smart Contract	Github user	Implements simple Foundation model where each incoming payment will be multiplied by specified campaign factor and sent to the destination	https://github.com/dblokhin/ton-charity-foundation
53	Smart contract lottery	Github user	Lottery smart contract where players buy any of 64 squares (or several), after a while the smart contract sets a win amount for each square	https://github.com/Arseny271/tonGame
54	Ring signature based mixer contract	Github user	Smart contract that can help obfuscates Grams	https://github.com/adoriasoft/ton_payment_mixer

Exhibit 4: List of Third-Party dApps and Features

#	Name	Developer	Notes Based on Third Party Description	Link(s)
55	Pool TON Service	vanasprin and alexhol	Allows to pool user funds in the TON blockchain network for some specific purpose and the subsequent proportional distribution of the funds (if necessary)	https://github.com/vanasprin/pool_ton
56	TON Staking Solutions	Eugene Koinov	Fully decentralized solution based on mutual mistrust principle at the crossroad of blockchain, finance and security	https://github.com/koinov/ton-staking
57	ICO smart contract	Github user	Allows user to conduct a fundraising event for the initial coin offer (ICO) for various projects	https://github.com/plexar88/ico
58	Dota2 auto chess	Github user	Project uses TON as a payment system and trust source for a popular game, Dota2 Autochess	https://github.com/KStasi/Ton-Dich5
59	TON Web	@dkaraush	A website portal for TON	https://tonweb.site/-1:d9bb6fde2410a2445f4e213013f5a0ac584a580a67478fa2992be4bae24c3079/index.html
60	Fungible token smart contract	Github user	Fungible token smart contract	https://github.com/adoriasoft/ton_fungible_token
61	messenger	Github user	Messenger for TON	https://github.com/AlexGor-dev/messenger
62	contract_manager	Github user	Manager contracts for ton blockchain	https://github.com/AlexGor-dev/contract_manager
63	A gambling smartcontract for Telegram Open Network (TON)	Denis Olshin	Smart-contract for TON blockchain implements a platform for different gambling activities (such as lotteries or card games)	https://github.com/deNULL/ton-gamble
64	Lottery "3 of 13" smart-contract	Github user	Lottery smart contract	https://github.com/alunegov/ton-contest-2
65	MadelineTon.js	Daniil Gentili	Pure JS client-side implementation of the Telegram TON blockchain protocol	https://github.com/danog/madelineTon.js
66	TON freestyle	Github user	Tools for creating freestyle smart contracts	https://github.com/Skydev0h/ton-freestyle
67	Ton (Gram) Validator Staking Pool	2masternodes	Validation aggregator	https://2masternodes.com/ton-validator-pool
68	Xeus-Fift	Github user	Jupyter kernels for Fift, FunC and TVM assembler	https://github.com/atomex-me/xeus-fift https://tontalk.org/threads/158/
69	TON Labs Cloud	TON Labs	Public cloud providing access to testnet	https://eu-central-1.large.testnet.ton.dev/graphql https://tontalk.org/threads/149/ https://decrypt.co/12531/telegrams-sec-battle-hasnt-stopped-ton-labs-pressing-ahead